WEST Search History

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DATE: Tuesday, January 25, 2005

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☐	L44	19722211	2
☐	L43	19721985	3
☐	L42	6741152	2
☐	L41	19839987	2
☐	L40	L39 and (flat$4 or planar or pancake or open or thermal$2 or heat$4 or temperature)	10
☐	L39	L38 and ((fluid$3 or water or coolant or liquid or cool$4 or (ethylene adj glycol)) with (gradient))	17
☐	L38	(heid.in.)	598
☐	L37	L36 and (pipe or plumbing or piping or piped)	4
☐	L36	L35 and ((fluid$3 or water or coolant or liquid or cool$4 or (ethylene adj glycol)) with (gradient))	13
☐	L35	L34 and (wound or winding or coiled or coiling or looping or loop or coil or helix or helical$3 or looped or spiral$4)	38
☐	L34	L33 and (flat$4 or planar or pancake or open or thermal$2 or heat$4 or temperature)	38
☐	L33	L32 and (switch$4)	38
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☐	L31	L30 and (shield$4)	112
☐	L30	L29 and ((magnetic adj resonance) or MRI or NMR)	169
☐	L29	L28 and ((transvers$4 or "x" or "y" or horizontal$2 or vertical$2) with (gradient or coil))	386
☐	L28	L27 and ((hollow or tube or cylindrical or cylinder or tubular or capilary or capillary) with (strip or tape or ribbon or conduct$4 or electric$4 or conduit or rod or bar or winding))	771
☐	L27	L26 and ((flow$4 or moving or move or movement or motion or movable or moved or pass or passing or passed or conduct$3 or direct$3 or divert$3)with (fluid$3 or water or coolant or liquid))	1485
☐	L26	L25 and (flow$4 or moving or move or movement or motion or movable or moved or pass or passing or passed or conduct$3 or direct$3 or divert$3)	2500
☐	L25	L24 and (wound or winding or coiled or coiling or looping or loop or coil or helix or helical$3 or looped)	2514

☐	L24	L23 and (strip or tape or ribbon or conduct$4 or electric$4 or conduit or rod or bar or winding)	2514
☐	L23	L2 and (fluid$3 or water or coolant or liquid)	2720
☐	L22	L17 and (water or (ethylene adj glycol))	21
☐	L21	L20 and (switch$4)	9
☐	L20	L19 and (shield$4)	10
☐	L19	L18 not L13	16
☐	L18	L17 and (flat$4 or planar or pancake or open or thermal$2 or heat$4 or temperature)	29
☐	L17	L11 and ((magnetic adj resonance) or MRI or NMR)	33
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☐	L15	L14 and (switch$4)	6
☐	L14	L13 and (shield$4)	17
☐	L13	L12 and (flat$4 or planar or pancake or open or thermal$2 or heat$4 or temperature)	26
☐	L12	L10 and (transvers$4 with (gradient or coil))	29
☐	L11	L9 and (transvers$4 with (gradient or coil))	61
☐	L10	L9 and (helix or helical$2 or spiral$2)	47
☐	L9	L8 and ((hollow or tube or cylindrical or cylinder or tubular) with (strip or tape or ribbon or conduct$4 or electric$4 or section))	119
☐	L8	L7 and ((flow$4 or moving or move or movement or motion or movable or moved or pass or passing or passed) with (fluid$3 or water or coolant or liquid))	204
☐	L7	L6 and (flow$4 or moving or move or movement or motion or movable or moved or pass or passing or passed)	433
☐	L6	L5 and (wound or winding or coiled or looped)	451
☐	L5	L4 and (strip or tape or ribbon or conduct$4 or electric$4)	914
☐	L4	L3 and (fluid$3 or water or coolant or liquid)	1002
☐	L3	L2 and (transvers$4)	1606
☐	L2	L1 and (hollow or tube or cylindrical or cylinder or tubular)	4771
☐	L1	(gradient with coil)	10174

END OF SEARCH HISTORY

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Search Results - Record(s) 1 through 38 of 38 returned.

1. Document ID: US 20040254419 A1

Using default format because multiple data bases are involved.

L33: Entry 1 of 38 File: PGPB Dec 16, 2004

PGPUB-DOCUMENT-NUMBER: 20040254419
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040254419 A1

TITLE: Therapeutic assembly

PUBLICATION-DATE: December 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	
Lanzafame, John	Victor	NY	US	
Weiner, Michael L.	Webster	NY	US	
Connelly, Patrick R.	Rochester	NY	US	

US-CL-CURRENT: 600/8; 424/1.11, 424/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. D

2. Document ID: US 20040225213 A1

L33: Entry 2 of 38 File: PGPB Nov 11, 2004

PGPUB-DOCUMENT-NUMBER: 20040225213
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040225213 A1

TITLE: Magnetic resonance imaging coated assembly

PUBLICATION-DATE: November 11, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	
Helfer, Jeffrey L.	Webster	NY	US	

Gray, Robert W.	Rochester	NY	US
Weiner, Michael L.	Webster	NY	US

US-CL-CURRENT: 600/421; 600/422, 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

3. Document ID: US 20040210289 A1

L33: Entry 3 of 38 File: PGPB Oct 21, 2004

PGPUB-DOCUMENT-NUMBER: 20040210289
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040210289 A1

TITLE: Novel nanomagnetic particles

PUBLICATION-DATE: October 21, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	

US-CL-CURRENT: 607/116

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

4. Document ID: US 20040199071 A1

L33: Entry 4 of 38 File: PGPB Oct 7, 2004

PGPUB-DOCUMENT-NUMBER: 20040199071
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040199071 A1

TITLE: Magnetic resonance imaging transseptal needle antenna

PUBLICATION-DATE: October 7, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Lardo, Albert C.	Baldwin	MD	US	
McVeigh, Elliott R.	Potomac	MD	US	
Halperin, Henry R.	Baltimore	MD	US	

US-CL-CURRENT: 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

5. Document ID: US 20040164738 A1

L33: Entry 5 of 38 File: PGPB Aug 26, 2004

PGPUB-DOCUMENT-NUMBER: 20040164738
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040164738 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: August 26, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/321

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw. De

6. Document ID: US 20040140808 A1

L33: Entry 6 of 38 File: PGPB Jul 22, 2004

PGPUB-DOCUMENT-NUMBER: 20040140808
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040140808 A1

TITLE: RF coil for imaging system

PUBLICATION-DATE: July 22, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Vaughan, J. Thomas JR.	Stillwater	MN	US	

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw. De

7. Document ID: US 20030189182 A1

L33: Entry 7 of 38 File: PGPB Oct 9, 2003

PGPUB-DOCUMENT-NUMBER: 20030189182
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030189182 A1

TITLE: Hyperpolarized gas containers, solenoids, transport and storage devices and

associated transport and storage methods

PUBLICATION-DATE: October 9, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Hasson, Kenton C.	Durham	NC	US	
Zollinger, Geri T.K.	Chapel Hill	NC	US	
Zollinger, David L.	Chapel Hill	NC	US	
Bogorad, Paul L.	Hillsborough	NC	US	
Wheeler, Bradley A.	Raleigh	NC	US	

US-CL-CURRENT: 251/129.2; 310/14

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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8. Document ID: US 20030146750 A1

L33: Entry 8 of 38 File: PGPB Aug 7, 2003

PGPUB-DOCUMENT-NUMBER: 20030146750
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030146750 A1

TITLE: RF coil for imaging system

PUBLICATION-DATE: August 7, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Vaughan, J. Thomas JR.	Stillwater	MN	US	

US-CL-CURRENT: 324/318; 707/104.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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9. Document ID: US 20030076104 A1

L33: Entry 9 of 38 File: PGPB Apr 24, 2003

PGPUB-DOCUMENT-NUMBER: 20030076104
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030076104 A1

TITLE: Nuclear magnetic resonance spectrometer for liquid-solution

PUBLICATION-DATE: April 24, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47

Okada, Michiya	Mito	JP
Wakuda, Tsuyoshi	Hitachi	JP
Kakugawa, Shigeru	Hitachi	JP
Morita, Hiroshi	Hitachi	JP
Aihara, Katsuzo	Hitachiota	JP

US-CL-CURRENT: 324/321; 324/312, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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10. Document ID: US 20030076103 A1

L33: Entry 10 of 38 File: PGPB Apr 24, 2003

PGPUB-DOCUMENT-NUMBER: 20030076103
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030076103 A1

TITLE: Nuclear magnetic resonance spectrometer for liquid-solution

PUBLICATION-DATE: April 24, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Okada, Michiya	Mito		JP	
Wakuda, Tsuyoshi	Hitachi		JP	
Kakugawa, Shigeru	Hitachi		JP	
Morita, Hiroshi	Hitachi		JP	
Aihara, Katsuzo	Hitachiota		JP	

US-CL-CURRENT: 324/321; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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11. Document ID: US 20030050527 A1

L33: Entry 11 of 38 File: PGPB Mar 13, 2003

PGPUB-DOCUMENT-NUMBER: 20030050527
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030050527 A1

TITLE: Apparatus and methods for delivery of transcranial magnetic stimulation

PUBLICATION-DATE: March 13, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Fox, Peter	San Antonio	TX	US	

Lancaster, Jack	San Antonio	TX	US
Dodd, Stephen	Austin	TX	US

US-CL-CURRENT: 600/13

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

12. Document ID: US 20030028094 A1

L33: Entry 12 of 38 File: PGPB Feb 6, 2003

PGPUB-DOCUMENT-NUMBER: 20030028094
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030028094 A1

TITLE: Biopsy and sampling needle antennas for magnetic resonance imaging-guided biopsies

PUBLICATION-DATE: February 6, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Kumar, Ananda	Baltimore	MD	US	
Atalar, Ergin	Columbia	MD	US	
Ocali, Ogan	Sunnyvale	CA	US	

US-CL-CURRENT: 600/410; 600/411, 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

13. Document ID: US 20020130661 A1

L33: Entry 13 of 38 File: PGPB Sep 19, 2002

PGPUB-DOCUMENT-NUMBER: 20020130661
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020130661 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: September 19, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
Fisher, George G.	Oak Harbor	WA	US	
Petucci, Christopher J.	Memphis	TN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/318; 324/309, 324/321, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

14. Document ID: US 20020073717 A1

L33: Entry 14 of 38 File: PGPB Jun 20, 2002

PGPUB-DOCUMENT-NUMBER: 20020073717
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020073717 A1

TITLE: MR scanner including liquid cooled RF coil and method

PUBLICATION-DATE: June 20, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Dean, David E.	Hartland	WI	US	
Assif, Benny	Ramat Hasharon		IL	
Hugg, James W.	Kiryat Hayim		IL	

US-CL-CURRENT: 62/50.7; 62/259.2, 62/51.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

15. Document ID: US 20010056232 A1

L33: Entry 15 of 38 File: PGPB Dec 27, 2001

PGPUB-DOCUMENT-NUMBER: 20010056232
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010056232 A1

TITLE: Magnetic resonance imaging transseptal needle antenna

PUBLICATION-DATE: December 27, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Lardo, Albert C.	Baldwin	MD	US	
McVeigh, Elliott R.	Potomac	MD	US	
Halperin, Henry R.	Baltimore	MD	US	

US-CL-CURRENT: 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

16. Document ID: US 6828892 B1

L33: Entry 16 of 38 File: USPT Dec 7, 2004

US-PAT-NO: 6828892
DOCUMENT-IDENTIFIER: US 6828892 B1

TITLE: Unilateral magnet having a remote uniform field region for nuclear magnetic resonance

DATE-ISSUED: December 7, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fukushima; Eiichi	Albuquerque	NM		
Jackson; Jasper A.	Redwood City	CA		

US-CL-CURRENT: 335/299; 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. D

☐ 17. Document ID: US 6812705 B1

L33: Entry 17 of 38 File: USPT Nov 2, 2004

US-PAT-NO: 6812705
DOCUMENT-IDENTIFIER: US 6812705 B1

TITLE: Coolant cooled RF body coil

DATE-ISSUED: November 2, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sellers; Michael Ben	Florence	SC		

US-CL-CURRENT: 324/318; 324/315

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. D

☐ 18. Document ID: US 6765144 B1

L33: Entry 18 of 38 File: USPT Jul 20, 2004

US-PAT-NO: 6765144
DOCUMENT-IDENTIFIER: US 6765144 B1

TITLE: Magnetic resonance imaging coated assembly

DATE-ISSUED: July 20, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wang; Xingwu	Wellsville	NY		
Greenwald; Howard J.	Rochester	NY		
Helfer; Jeffrey L.	Webster	NY		
Gray; Robert W.	Rochester	NY		
Weiner; Michael L.	Webster	NY		

US-CL-CURRENT: 174/36; 333/12

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

19. Document ID: US 6696838 B2

L33: Entry 19 of 38 File: USPT Feb 24, 2004

US-PAT-NO: 6696838
DOCUMENT-IDENTIFIER: US 6696838 B2

TITLE: Nuclear magnetic resonance analysis of multiple samples

DATE-ISSUED: February 24, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Raftery; Daniel	Lafayette	IN		
Fisher; George G.	Oak Harbor	WA		
McNamara; Ernesto	Alexandria	VA		

US-CL-CURRENT: 324/321; 324/310, 324/318, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

20. Document ID: US 6633161 B1

L33: Entry 20 of 38 File: USPT Oct 14, 2003

US-PAT-NO: 6633161
DOCUMENT-IDENTIFIER: US 6633161 B1

TITLE: RF coil for imaging system

DATE-ISSUED: October 14, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Vaughan, Jr.; J. Thomas	Stillwater	MN		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

21. Document ID: US 6606513 B2

L33: Entry 21 of 38 File: USPT Aug 12, 2003

US-PAT-NO: 6606513
DOCUMENT-IDENTIFIER: US 6606513 B2

TITLE: Magnetic resonance imaging transseptal needle antenna

DATE-ISSUED: August 12, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lardo; Albert C.	Baldwin	MD		
McVeigh; Elliott R.	Potomac	MD		
Halperin; Henry R.	Baltimore	MD		

US-CL-CURRENT: 600/411; 324/318, 600/423, 600/424

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

22. Document ID: US 6489872 B1

L33: Entry 22 of 38 File: USPT Dec 3, 2002

US-PAT-NO: 6489872
DOCUMENT-IDENTIFIER: US 6489872 B1

TITLE: Unilateral magnet having a remote uniform field region for nuclear magnetic resonance

DATE-ISSUED: December 3, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fukushima; Eiichi	Albuquerque	NM		
Jackson; Jasper A.	Albuquerque	NM		

US-CL-CURRENT: 335/299; 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

23. Document ID: US 6430939 B1

L33: Entry 23 of 38 File: USPT Aug 13, 2002

US-PAT-NO: 6430939

DOCUMENT-IDENTIFIER: US 6430939 B1
**** See image for Certificate of Correction ****

TITLE: Hyperpolarized gas containers,solenoids, transport and storage devices and associated transport and storage methods

DATE-ISSUED: August 13, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hasson; Kenton C.	Durham	NC		
Zollinger; Geri T. K.	Chapel Hill	NC		
Zollinger; David L.	Chapel Hill	NC		
Bogorad; Paul L.	Hillsborough	NC		
Wheeler; Bradley A.	Raleigh	NC		

US-CL-CURRENT: 62/49.1; 600/420, 604/181, 604/20

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

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24. Document ID: US 6275039 B1

L33: Entry 24 of 38 File: USPT Aug 14, 2001

US-PAT-NO: 6275039
DOCUMENT-IDENTIFIER: US 6275039 B1

TITLE: Magnetic resonance pre-polarization apparatus

DATE-ISSUED: August 14, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Young; Ian Robert	Marlborough			GB
Eastham; John Frederick	Bath			GB

US-CL-CURRENT: 324/319; 324/300, 324/306, 324/307, 324/309, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

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25. Document ID: US 6111412 A

L33: Entry 25 of 38 File: USPT Aug 29, 2000

US-PAT-NO: 6111412
DOCUMENT-IDENTIFIER: US 6111412 A

TITLE: Gradient coil assembly and method of production of same

DATE-ISSUED: August 29, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Schuster; Johann	Oberasbach			DE
Kaindl; Arthur	Erlangen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

26. Document ID: US 5886548 A

L33: Entry 26 of 38 File: USPT Mar 23, 1999

US-PAT-NO: 5886548
DOCUMENT-IDENTIFIER: US 5886548 A

TITLE: Crescent gradient coils

DATE-ISSUED: March 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

27. Document ID: US 5804968 A

L33: Entry 27 of 38 File: USPT Sep 8, 1998

US-PAT-NO: 5804968
DOCUMENT-IDENTIFIER: US 5804968 A

TITLE: Gradient coils with reduced eddy currents

DATE-ISSUED: September 8, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Richard; Mark A.	S. Euclid	OH		
Mastandrea, Jr.; Nicholas J.	Euclid	OH		
Lampman; David A.	Eastlake	OH		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

28. Document ID: US 5748063 A

L33: Entry 28 of 38 File: USPT May 5, 1998

US-PAT-NO: 5748063
DOCUMENT-IDENTIFIER: US 5748063 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: May 5, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/299; 324/319, 335/301

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

29. Document ID: US 5717371 A

L33: Entry 29 of 38 File: USPT Feb 10, 1998

US-PAT-NO: 5717371
DOCUMENT-IDENTIFIER: US 5717371 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: February 10, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James Terry	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

30. Document ID: US 5685305 A

L33: Entry 30 of 38 File: USPT Nov 11, 1997

US-PAT-NO: 5685305
DOCUMENT-IDENTIFIER: US 5685305 A

TITLE: Method and system for MRI detection of abnormal blood flow

DATE-ISSUED: November 11, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Moonen; Chrit T. W.	Kensington	MD		
Duyn; Jeff	Kensington	MD		
van Gelderen; Peter	Kensington	MD		

US-CL-CURRENT: 600/419; 324/306

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

31. Document ID: US 5642087 A

L33: Entry 31 of 38 File: USPT Jun 24, 1997

US-PAT-NO: 5642087
DOCUMENT-IDENTIFIER: US 5642087 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: June 24, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318, 335/299

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

32. Document ID: US 5554929 A

L33: Entry 32 of 38 File: USPT Sep 10, 1996

US-PAT-NO: 5554929
DOCUMENT-IDENTIFIER: US 5554929 A

TITLE: Crescent gradient coils

DATE-ISSUED: September 10, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

33. Document ID: US 5424643 A

L33: Entry 33 of 38 File: USPT Jun 13, 1995

US-PAT-NO: 5424643
DOCUMENT-IDENTIFIER: US 5424643 A

TITLE: Magnetic resonance gradient sheet coils

DATE-ISSUED: June 13, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Morich; Michael A.	Mentor	OH		
Patrick; John L.	Chagrin Falls	OH		
DeMeester; Gordon D.	Wickliffe	OH		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

34. Document ID: US 5414399 A

L33: Entry 34 of 38 File: USPT May 9, 1995

US-PAT-NO: 5414399
DOCUMENT-IDENTIFIER: US 5414399 A

TITLE: Open access superconducting MRI magnet having an apparatus for reducing magnetic hysteresis in superconducting MRI systems

DATE-ISSUED: May 9, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Breneman; Bruce C.	San Diego	CA		
Sarwinski; Raymond E.	San Diego	CA		
Hsu; Yen-Hwa L.	Solana Beach	CA		

US-CL-CURRENT: 335/301; 324/318, 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

35. Document ID: US 5323135 A

L33: Entry 35 of 38 File: USPT Jun 21, 1994

US-PAT-NO: 5323135
DOCUMENT-IDENTIFIER: US 5323135 A

TITLE: Method for the construction of an optimized magnet coil

DATE-ISSUED: June 21, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schmidt; Hartmut	Karlsruhe			DE
Westphal; Michael	Offenbach			DE

US-CL-CURRENT: 335/299; 324/318, 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

36. Document ID: US 5304933 A

L33: Entry 36 of 38 File: USPT Apr 19, 1994

US-PAT-NO: 5304933
DOCUMENT-IDENTIFIER: US 5304933 A

TITLE: Surgical local gradient coil

DATE-ISSUED: April 19, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Vavrek; Robert M.	Waukesha	WI		
Myers; Christopher C.	Milwaukee	WI		

US-CL-CURRENT: 324/318; 324/300

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

37. Document ID: US 5220800 A

L33: Entry 37 of 38 File: USPT Jun 22, 1993

US-PAT-NO: 5220800
DOCUMENT-IDENTIFIER: US 5220800 A

TITLE: NMR magnet system with superconducting coil in a helium bath

DATE-ISSUED: June 22, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Muller; Wolfgang H.	Karlsruhe			DE

Roth; Gerhard	Karlsruhe	DE
Stautner; Wolfgang	Stutensee-Buchig	DE
Turowski; Peter	Leopoldshafen	DE
Lehmann; Wolfgang	Leopoldshafen	DE
Graf; Franz	Karlsruhe	DE

US-CL-CURRENT: 62/51.1; 335/216, 505/892

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

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38. Document ID: US 3268800 A

L33: Entry 38 of 38 File: USOC Aug 23, 1966

US-PAT-NO: 3268800
DOCUMENT-IDENTIFIER: US 3268800 A

TITLE: Nuclear magnetic resonance well logging

DATE-ISSUED: August 23, 1966

INVENTOR-NAME: HOEHN JR GUSTAVE L; WOESSNER DONALD E ; ZIMMERMAN JR JOHN R

US-CL-CURRENT: 324/303

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

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Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
SWITCH$4	0
SWITCH	1903994
SWITCHA	210
SWITCHAAID	1
SWITCHAAP	1
SWITCHAB	11
SWITCHABAR	1
SWITCHABE	5
SWITCHABIC	2
SWITCHABID	1
SWITCHABIE	4
(L32 AND (SWITCH$4)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	38

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☐ 1. Document ID: US 20040254419 A1

Using default format because multiple data bases are involved.

L35: Entry 1 of 38 File: PGPB Dec 16, 2004

PGPUB-DOCUMENT-NUMBER: 20040254419
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040254419 A1

TITLE: Therapeutic assembly

PUBLICATION-DATE: December 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	
Lanzafame, John	Victor	NY	US	
Weiner, Michael L.	Webster	NY	US	
Connelly, Patrick R.	Rochester	NY	US	

US-CL-CURRENT: 600/8; 424/1.11, 424/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

☐ 2. Document ID: US 20040225213 A1

L35: Entry 2 of 38 File: PGPB Nov 11, 2004

PGPUB-DOCUMENT-NUMBER: 20040225213
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040225213 A1

TITLE: Magnetic resonance imaging coated assembly

PUBLICATION-DATE: November 11, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	
Helfer, Jeffrey L.	Webster	NY	US	

Gray, Robert W.	Rochester	NY	US
Weiner, Michael L.	Webster	NY	US

US-CL-CURRENT: 600/421; 600/422, 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

3. Document ID: US 20040210289 A1

L35: Entry 3 of 38 File: PGPB Oct 21, 2004

PGPUB-DOCUMENT-NUMBER: 20040210289
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040210289 A1

TITLE: Novel nanomagnetic particles

PUBLICATION-DATE: October 21, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	

US-CL-CURRENT: 607/116

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

4. Document ID: US 20040199071 A1

L35: Entry 4 of 38 File: PGPB Oct 7, 2004

PGPUB-DOCUMENT-NUMBER: 20040199071
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040199071 A1

TITLE: Magnetic resonance imaging transseptal needle antenna

PUBLICATION-DATE: October 7, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Lardo, Albert C.	Baldwin	MD	US	
McVeigh, Elliott R.	Potomac	MD	US	
Halperin, Henry R.	Baltimore	MD	US	

US-CL-CURRENT: 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

5. Document ID: US 20040164738 A1

L35: Entry 5 of 38 File: PGPB Aug 26, 2004

PGPUB-DOCUMENT-NUMBER: 20040164738
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040164738 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: August 26, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/321

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. D

6. Document ID: US 20040140808 A1

L35: Entry 6 of 38 File: PGPB Jul 22, 2004

PGPUB-DOCUMENT-NUMBER: 20040140808
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040140808 A1

TITLE: RF coil for imaging system

PUBLICATION-DATE: July 22, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Vaughan, J. Thomas JR.	Stillwater	MN	US	

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. D

7. Document ID: US 20030189182 A1

L35: Entry 7 of 38 File: PGPB Oct 9, 2003

PGPUB-DOCUMENT-NUMBER: 20030189182
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030189182 A1

TITLE: Hyperpolarized gas containers, solenoids, transport and storage devices and

associated transport and storage methods

PUBLICATION-DATE: October 9, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Hasson, Kenton C.	Durham	NC	US	
Zollinger, Geri T.K.	Chapel Hill	NC	US	
Zollinger, David L.	Chapel Hill	NC	US	
Bogorad, Paul L.	Hillsborough	NC	US	
Wheeler, Bradley A.	Raleigh	NC	US	

US-CL-CURRENT: 251/129.2; 310/14

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

8. Document ID: US 20030146750 A1

L35: Entry 8 of 38 File: PGPB Aug 7, 2003

PGPUB-DOCUMENT-NUMBER: 20030146750
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030146750 A1

TITLE: RF coil for imaging system

PUBLICATION-DATE: August 7, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Vaughan, J. Thomas JR.	Stillwater	MN	US	

US-CL-CURRENT: 324/318; 707/104.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

9. Document ID: US 20030076104 A1

L35: Entry 9 of 38 File: PGPB Apr 24, 2003

PGPUB-DOCUMENT-NUMBER: 20030076104
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030076104 A1

TITLE: Nuclear magnetic resonance spectrometer for liquid-solution

PUBLICATION-DATE: April 24, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47

Okada, Michiya	Mito	JP
Wakuda, Tsuyoshi	Hitachi	JP
Kakugawa, Shigeru	Hitachi	JP
Morita, Hiroshi	Hitachi	JP
Aihara, Katsuzo	Hitachiota	JP

US-CL-CURRENT: 324/321; 324/312, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

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10. Document ID: US 20030076103 A1

L35: Entry 10 of 38 File: PGPB Apr 24, 2003

PGPUB-DOCUMENT-NUMBER: 20030076103
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030076103 A1

TITLE: Nuclear magnetic resonance spectrometer for liquid-solution

PUBLICATION-DATE: April 24, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Okada, Michiya	Mito		JP	
Wakuda, Tsuyoshi	Hitachi		JP	
Kakugawa, Shigeru	Hitachi		JP	
Morita, Hiroshi	Hitachi		JP	
Aihara, Katsuzo	Hitachiota		JP	

US-CL-CURRENT: 324/321; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw D

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11. Document ID: US 20030050527 A1

L35: Entry 11 of 38 File: PGPB Mar 13, 2003

PGPUB-DOCUMENT-NUMBER: 20030050527
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030050527 A1

TITLE: Apparatus and methods for delivery of transcranial magnetic stimulation

PUBLICATION-DATE: March 13, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Fox, Peter	San Antonio	TX	US	

Lancaster, Jack	San Antonio	TX	US
Dodd, Stephen	Austin	TX	US

US-CL-CURRENT: 600/13

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw. D

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12. Document ID: US 20030028094 A1

L35: Entry 12 of 38 File: PGPB Feb 6, 2003

PGPUB-DOCUMENT-NUMBER: 20030028094
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030028094 A1

TITLE: Biopsy and sampling needle antennas for magnetic resonance imaging-guided biopsies

PUBLICATION-DATE: February 6, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Kumar, Ananda	Baltimore	MD	US	
Atalar, Ergin	Columbia	MD	US	
Ocali, Ogan	Sunnyvale	CA	US	

US-CL-CURRENT: 600/410; 600/411, 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw. D

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13. Document ID: US 20020130661 A1

L35: Entry 13 of 38 File: PGPB Sep 19, 2002

PGPUB-DOCUMENT-NUMBER: 20020130661
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020130661 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: September 19, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
Fisher, George G.	Oak Harbor	WA	US	
Petucci, Christopher J.	Memphis	TN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/318; 324/309, 324/321, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. De

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14. Document ID: US 20020073717 A1

L35: Entry 14 of 38 File: PGPB Jun 20, 2002

PGPUB-DOCUMENT-NUMBER: 20020073717
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020073717 A1

TITLE: MR scanner including liquid cooled RF coil and method

PUBLICATION-DATE: June 20, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Dean, David E.	Hartland	WI	US	
Assif, Benny	Ramat Hasharon		IL	
Hugg, James W.	Kiryat Hayim		IL	

US-CL-CURRENT: 62/50.7; 62/259.2, 62/51.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. De

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15. Document ID: US 20010056232 A1

L35: Entry 15 of 38 File: PGPB Dec 27, 2001

PGPUB-DOCUMENT-NUMBER: 20010056232
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010056232 A1

TITLE: Magnetic resonance imaging transseptal needle antenna

PUBLICATION-DATE: December 27, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Lardo, Albert C.	Baldwin	MD	US	
McVeigh, Elliott R.	Potomac	MD	US	
Halperin, Henry R.	Baltimore	MD	US	

US-CL-CURRENT: 600/423

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. De

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16. Document ID: US 6828892 B1

L35: Entry 16 of 38 File: USPT Dec 7, 2004

US-PAT-NO: 6828892
DOCUMENT-IDENTIFIER: US 6828892 B1

TITLE: Unilateral magnet having a remote uniform field region for nuclear magnetic resonance

DATE-ISSUED: December 7, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fukushima; Eiichi	Albuquerque	NM		
Jackson; Jasper A.	Redwood City	CA		

US-CL-CURRENT: 335/299; 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

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☐ 17. Document ID: US 6812705 B1

L35: Entry 17 of 38 File: USPT Nov 2, 2004

US-PAT-NO: 6812705
DOCUMENT-IDENTIFIER: US 6812705 B1

TITLE: Coolant cooled RF body coil

DATE-ISSUED: November 2, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sellers; Michael Ben	Florence	SC		

US-CL-CURRENT: 324/318; 324/315

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

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☐ 18. Document ID: US 6765144 B1

L35: Entry 18 of 38 File: USPT Jul 20, 2004

US-PAT-NO: 6765144
DOCUMENT-IDENTIFIER: US 6765144 B1

TITLE: Magnetic resonance imaging coated assembly

DATE-ISSUED: July 20, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wang; Xingwu	Wellsville	NY		
Greenwald; Howard J.	Rochester	NY		
Helfer; Jeffrey L.	Webster	NY		
Gray; Robert W.	Rochester	NY		
Weiner; Michael L.	Webster	NY		

US-CL-CURRENT: 174/36; 333/12

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. D

19. Document ID: US 6696838 B2

L35: Entry 19 of 38 File: USPT Feb 24, 2004

US-PAT-NO: 6696838
DOCUMENT-IDENTIFIER: US 6696838 B2

TITLE: Nuclear magnetic resonance analysis of multiple samples

DATE-ISSUED: February 24, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Raftery; Daniel	Lafayette	IN		
Fisher; George G.	Oak Harbor	WA		
McNamara; Ernesto	Alexandria	VA		

US-CL-CURRENT: 324/321; 324/310, 324/318, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. D

20. Document ID: US 6633161 B1

L35: Entry 20 of 38 File: USPT Oct 14, 2003

US-PAT-NO: 6633161
DOCUMENT-IDENTIFIER: US 6633161 B1

TITLE: RF coil for imaging system

DATE-ISSUED: October 14, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Vaughan, Jr.; J. Thomas	Stillwater	MN		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. De

21. Document ID: US 6606513 B2

L35: Entry 21 of 38 File: USPT Aug 12, 2003

US-PAT-NO: 6606513
DOCUMENT-IDENTIFIER: US 6606513 B2

TITLE: Magnetic resonance imaging transseptal needle antenna

DATE-ISSUED: August 12, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lardo; Albert C.	Baldwin	MD		
McVeigh; Elliott R.	Potomac	MD		
Halperin; Henry R.	Baltimore	MD		

US-CL-CURRENT: 600/411; 324/318, 600/423, 600/424

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. De

22. Document ID: US 6489872 B1

L35: Entry 22 of 38 File: USPT Dec 3, 2002

US-PAT-NO: 6489872
DOCUMENT-IDENTIFIER: US 6489872 B1

TITLE: Unilateral magnet having a remote uniform field region for nuclear magnetic resonance

DATE-ISSUED: December 3, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fukushima; Eiichi	Albuquerque	NM		
Jackson; Jasper A.	Albuquerque	NM		

US-CL-CURRENT: 335/299; 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. De

23. Document ID: US 6430939 B1

L35: Entry 23 of 38 File: USPT Aug 13, 2002

US-PAT-NO: 6430939

DOCUMENT-IDENTIFIER: US 6430939 B1
**** See image for Certificate of Correction ****

TITLE: Hyperpolarized gas containers,solenoids, transport and storage devices and associated transport and storage methods

DATE-ISSUED: August 13, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hasson; Kenton C.	Durham	NC		
Zollinger; Geri T. K.	Chapel Hill	NC		
Zollinger; David L.	Chapel Hill	NC		
Bogorad; Paul L.	Hillsborough	NC		
Wheeler; Bradley A.	Raleigh	NC		

US-CL-CURRENT: 62/49.1; 600/420, 604/181, 604/20

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

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24. Document ID: US 6275039 B1

L35: Entry 24 of 38 File: USPT Aug 14, 2001

US-PAT-NO: 6275039
DOCUMENT-IDENTIFIER: US 6275039 B1

TITLE: Magnetic resonance pre-polarization apparatus

DATE-ISSUED: August 14, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Young; Ian Robert	Marlborough			GB
Eastham; John Frederick	Bath			GB

US-CL-CURRENT: 324/319; 324/300, 324/306, 324/307, 324/309, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

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25. Document ID: US 6111412 A

L35: Entry 25 of 38 File: USPT Aug 29, 2000

US-PAT-NO: 6111412
DOCUMENT-IDENTIFIER: US 6111412 A

TITLE: Gradient coil assembly and method of production of same

DATE-ISSUED: August 29, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Schuster; Johann	Oberasbach			DE
Kaindl; Arthur	Erlangen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

26. Document ID: US 5886548 A

L35: Entry 26 of 38 File: USPT Mar 23, 1999

US-PAT-NO: 5886548
DOCUMENT-IDENTIFIER: US 5886548 A

TITLE: Crescent gradient coils

DATE-ISSUED: March 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

27. Document ID: US 5804968 A

L35: Entry 27 of 38 File: USPT Sep 8, 1998

US-PAT-NO: 5804968
DOCUMENT-IDENTIFIER: US 5804968 A

TITLE: Gradient coils with reduced eddy currents

DATE-ISSUED: September 8, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Richard; Mark A.	S. Euclid	OH		
Mastandrea, Jr.; Nicholas J.	Euclid	OH		
Lampman; David A.	Eastlake	OH		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

28. Document ID: US 5748063 A

L35: Entry 28 of 38 File: USPT May 5, 1998

US-PAT-NO: 5748063
DOCUMENT-IDENTIFIER: US 5748063 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: May 5, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/299; 324/319, 335/301

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

29. Document ID: US 5717371 A

L35: Entry 29 of 38 File: USPT Feb 10, 1998

US-PAT-NO: 5717371
DOCUMENT-IDENTIFIER: US 5717371 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: February 10, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James Terry	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

30. Document ID: US 5685305 A

L35: Entry 30 of 38 File: USPT Nov 11, 1997

US-PAT-NO: 5685305
DOCUMENT-IDENTIFIER: US 5685305 A

TITLE: Method and system for MRI detection of abnormal blood flow

DATE-ISSUED: November 11, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Moonen; Chrit T. W.	Kensington	MD		
Duyn; Jeff	Kensington	MD		
van Gelderen; Peter	Kensington	MD		

US-CL-CURRENT: 600/419; 324/306

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

☐ 31. Document ID: US 5642087 A

L35: Entry 31 of 38 File: USPT Jun 24, 1997

US-PAT-NO: 5642087
DOCUMENT-IDENTIFIER: US 5642087 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: June 24, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318, 335/299

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw De

☐ 32. Document ID: US 5554929 A

L35: Entry 32 of 38 File: USPT Sep 10, 1996

US-PAT-NO: 5554929
DOCUMENT-IDENTIFIER: US 5554929 A

TITLE: Crescent gradient coils

DATE-ISSUED: September 10, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

☐ 33. Document ID: US 5424643 A

L35: Entry 33 of 38 File: USPT Jun 13, 1995

US-PAT-NO: 5424643
DOCUMENT-IDENTIFIER: US 5424643 A

TITLE: Magnetic resonance gradient sheet coils

DATE-ISSUED: June 13, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Morich; Michael A.	Mentor	OH		
Patrick; John L.	Chagrin Falls	OH		
DeMeester; Gordon D.	Wickliffe	OH		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

☐ 34. Document ID: US 5414399 A

L35: Entry 34 of 38 File: USPT May 9, 1995

US-PAT-NO: 5414399
DOCUMENT-IDENTIFIER: US 5414399 A

TITLE: Open access superconducting MRI magnet having an apparatus for reducing magnetic hysteresis in superconducting MRI systems

DATE-ISSUED: May 9, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Breneman; Bruce C.	San Diego	CA		
Sarwinski; Raymond E.	San Diego	CA		
Hsu; Yen-Hwa L.	Solana Beach	CA		

US-CL-CURRENT: 335/301; 324/318, 335/216

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

☐ 35. Document ID: US 5323135 A

L35: Entry 35 of 38 File: USPT Jun 21, 1994

US-PAT-NO: 5323135
DOCUMENT-IDENTIFIER: US 5323135 A

TITLE: Method for the construction of an optimized magnet coil

DATE-ISSUED: June 21, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schmidt; Hartmut	Karlsruhe			DE
Westphal; Michael	Offenbach			DE

US-CL-CURRENT: 335/299; 324/318, 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

36. Document ID: US 5304933 A

L35: Entry 36 of 38 File: USPT Apr 19, 1994

US-PAT-NO: 5304933
DOCUMENT-IDENTIFIER: US 5304933 A

TITLE: Surgical local gradient coil

DATE-ISSUED: April 19, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Vavrek; Robert M.	Waukesha	WI		
Myers; Christopher C.	Milwaukee	WI		

US-CL-CURRENT: 324/318; 324/300

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

37. Document ID: US 5220800 A

L35: Entry 37 of 38 File: USPT Jun 22, 1993

US-PAT-NO: 5220800
DOCUMENT-IDENTIFIER: US 5220800 A

TITLE: NMR magnet system with superconducting coil in a helium bath

DATE-ISSUED: June 22, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Muller; Wolfgang H.	Karlsruhe			DE

Roth; Gerhard	Karlsruhe	DE
Stautner; Wolfgang	Stutensee-Buchig	DE
Turowski; Peter	Leopoldshafen	DE
Lehmann; Wolfgang	Leopoldshafen	DE
Graf; Franz	Karlsruhe	DE

US-CL-CURRENT: 62/51.1; 335/216, 505/892

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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38. Document ID: US 3268800 A

L35: Entry 38 of 38 File: USOC Aug 23, 1966

US-PAT-NO: 3268800
DOCUMENT-IDENTIFIER: US 3268800 A

TITLE: Nuclear magnetic resonance well logging

DATE-ISSUED: August 23, 1966

INVENTOR-NAME: HOEHN JR GUSTAVE L; WOESSNER DONALD E ; ZIMMERMAN JR JOHN R

US-CL-CURRENT: 324/303

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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Term	Documents
WOUND	690343
WOUNDS	28236
WINDING	677037
WINDINGS	231470
COILED	196996
COILEDS	8
COILING	35897
COILINGS	143
LOOPING	29412
LOOPINGS	151
LOOP	798093
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Search Results - Record(s) 1 through 13 of 13 returned.

1. Document ID: US 20040254419 A1

Using default format because multiple data bases are involved.

L36: Entry 1 of 13 File: PGPB Dec 16, 2004

PGPUB-DOCUMENT-NUMBER: 20040254419
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040254419 A1

TITLE: Therapeutic assembly

PUBLICATION-DATE: December 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wang, Xingwu	Wellsville	NY	US	
Greenwald, Howard J.	Rochester	NY	US	
Lanzafame, John	Victor	NY	US	
Weiner, Michael L.	Webster	NY	US	
Connelly, Patrick R.	Rochester	NY	US	

US-CL-CURRENT: 600/8; 424/1.11, 424/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

2. Document ID: US 20040164738 A1

L36: Entry 2 of 13 File: PGPB Aug 26, 2004

PGPUB-DOCUMENT-NUMBER: 20040164738
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040164738 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: August 26, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/321

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw D

3. Document ID: US 20020130661 A1

L36: Entry 3 of 13 File: PGPB Sep 19, 2002

PGPUB-DOCUMENT-NUMBER: 20020130661
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020130661 A1

TITLE: Nuclear magnetic resonance analysis of multiple samples

PUBLICATION-DATE: September 19, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Raftery, Daniel	Lafayette	IN	US	
Fisher, George G.	Oak Harbor	WA	US	
Petucci, Christopher J.	Memphis	TN	US	
McNamara, Ernesto	Alexandria	VA	US	

US-CL-CURRENT: 324/318; 324/309, 324/321, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw D

4. Document ID: US 20020073717 A1

L36: Entry 4 of 13 File: PGPB Jun 20, 2002

PGPUB-DOCUMENT-NUMBER: 20020073717
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020073717 A1

TITLE: MR scanner including liquid cooled RF coil and method

PUBLICATION-DATE: June 20, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Dean, David E.	Hartland	WI	US	
Assif, Benny	Ramat Hasharon		IL	
Hugg, James W.	Kiryat Hayim		IL	

US-CL-CURRENT: 62/50.7; 62/259.2, 62/51.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw D

5. Document ID: US 6812705 B1

L36: Entry 5 of 13 File: USPT Nov 2, 2004

US-PAT-NO: 6812705
DOCUMENT-IDENTIFIER: US 6812705 B1

TITLE: Coolant cooled RF body coil

DATE-ISSUED: November 2, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sellers; Michael Ben	Florence	SC		

US-CL-CURRENT: 324/318; 324/315

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Drawn D

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6. Document ID: US 6696838 B2

L36: Entry 6 of 13 File: USPT Feb 24, 2004

US-PAT-NO: 6696838
DOCUMENT-IDENTIFIER: US 6696838 B2

TITLE: Nuclear magnetic resonance analysis of multiple samples

DATE-ISSUED: February 24, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Raftery; Daniel	Lafayette	IN		
Fisher; George G.	Oak Harbor	WA		
McNamara; Ernesto	Alexandria	VA		

US-CL-CURRENT: 324/321; 324/310, 324/318, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Drawn D

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7. Document ID: US 6111412 A

L36: Entry 7 of 13 File: USPT Aug 29, 2000

US-PAT-NO: 6111412
DOCUMENT-IDENTIFIER: US 6111412 A

TITLE: Gradient coil assembly and method of production of same

DATE-ISSUED: August 29, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Schuster; Johann	Oberasbach			DE
Kaindl; Arthur	Erlangen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

8. Document ID: US 5886548 A

L36: Entry 8 of 13 File: USPT Mar 23, 1999

US-PAT-NO: 5886548
DOCUMENT-IDENTIFIER: US 5886548 A

TITLE: Crescent gradient coils

DATE-ISSUED: March 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

9. Document ID: US 5748063 A

L36: Entry 9 of 13 File: USPT May 5, 1998

US-PAT-NO: 5748063
DOCUMENT-IDENTIFIER: US 5748063 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: May 5, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/299; 324/319, 335/301

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

☐ 10. Document ID: US 5717371 A

L36: Entry 10 of 13 File: USPT Feb 10, 1998

US-PAT-NO: 5717371
DOCUMENT-IDENTIFIER: US 5717371 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: February 10, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James Terry	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

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☐ 11. Document ID: US 5642087 A

L36: Entry 11 of 13 File: USPT Jun 24, 1997

US-PAT-NO: 5642087
DOCUMENT-IDENTIFIER: US 5642087 A

TITLE: Generating highly uniform electromagnetic field characteristics

DATE-ISSUED: June 24, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Crow; James T.	Albuquerque	NM		

US-CL-CURRENT: 335/216; 324/318, 335/299

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

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☐ 12. Document ID: US 5554929 A

L36: Entry 12 of 13 File: USPT Sep 10, 1996

US-PAT-NO: 5554929
DOCUMENT-IDENTIFIER: US 5554929 A

TITLE: Crescent gradient coils

DATE-ISSUED: September 10, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY

Doty; F. David	Columbia	SC
Wilcher; James K.	Columbia	SC

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

13. Document ID: US 5424643 A

L36: Entry 13 of 13 File: USPT Jun 13, 1995

US-PAT-NO: 5424643
DOCUMENT-IDENTIFIER: US 5424643 A

TITLE: Magnetic resonance gradient sheet coils

DATE-ISSUED: June 13, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Morich; Michael A.	Mentor	OH		
Patrick; John L.	Chagrin Falls	OH		
DeMeester; Gordon D.	Wickliffe	OH		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. De

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Term	Documents
WATER	3821567
WATERS	78774
COOLANT	173169
COOLANTS	10728
LIQUID	2763704
LIQ	360031
LIQS	12871
LIQUIDS	395769
ETHYLENE	687260
ETHYLENES	3041
GLYCOL	498762
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(GRADIENT))).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	

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L36: Entry 7 of 13 File: USPT Aug 29, 2000

DOCUMENT-IDENTIFIER: US 6111412 A
TITLE: Gradient coil assembly and method of production of same

Abstract Text (1):
A gradient coil assembly for an NMR tomography apparatus has at least one gradient coil and at least one cooling structure, the cooling structure including at least one flexible cooling conduit for a cooling medium, this conduit being arranged on a flexible carrier. In a method for producing such a gradient coil assembly, a gradient coil and a cooling structure are flexibly attached to a flexible carrier, with the cooling structure being in thermally conducting contact with the gradient coil.

Brief Summary Text (3):
The present invention is directed to a gradient coil assembly for an NMR tomography apparatus, the assembly being of the type having at least one gradient coil and one cooling structure, as well as to a method for producing such a gradient coil assembly.

Brief Summary Text (5):
In the operation of an NMR tomography apparatus, for image creation it is necessary to superimpose at least one magnetic field gradient onto a basic magnetic field. This occurs by means of a gradient coil assembly arranged in the basic field. The gradient coil arrangement typically includes a number of coils in order to create three magnetic field gradients residing perpendicularly relative to one another. In the actively shielded gradient coils frequently used today, in addition to the primary coils which create the useful field, secondary coils must be present which prevent the creation of eddy currents in metallic parts surrounding the gradient coil. These secondary coils are arranged concentrically about the primary coils and are at a distance therefrom. Typically, each gradient coil is permeated by a pulse-like current on the order of magnitude of about 300 A. Due to the ohmic resistance of the coil, a considerable amount of energy is converted into heat.

Brief Summary Text (6):
This heat must be conveyed away in a suitable manner. In an NMR tomography apparatus for solid-state examinations, a good cooling of the gradient coils is particularly necessary, because the patient lies in the interior space of the gradient coil assembly, which is constructed in a tubular shape. Excessive heating of this assembly would be uncomfortable for the patient and would compromise the willingness of patients to undergo NMR tomographic examinations.

Brief Summary Text (7):
German Patentschrift 41 41 514 teaches a gradient coil assembly of the above type. Ventilation channels serve as cooling means, these channels being formed in the assembly by U-shaped profiles through the interior space.

Brief Summary Text (8):
In this gradient coil assembly, however, the incorporation of the channels for the cooling medium into the assembly is costly, and the heat conveyance is not optimal.

Brief Summary Text (9):
German OS 34 04 457 teaches an arrangement for cooling a magnet system, this arrangement being provided particularly for attachment to a basic field coil of an NMR tomography apparatus. The cooling includes a number of cooling elements with a heat conductor plate in the form of a ring wheel, this plate being provided with a number of radial slots distributed uniformly around the circumference of the plate. A cooling agent conduit is soldered or welded onto the heat conduit plate or embedded or pressed or cemented into the heat conduit plate.

Brief Summary Text (11):
German OS 40 17 260 discloses a method for the production of a gradient coil arrangement of an MRI apparatus.

Brief Summary Text (13):
It is an object of the present invention to provide an adequately cooled gradient coil assembly which can accommodate non-planar gradient coils and in which a capable cooling structure is contained with a relatively low outlay.

Brief Summary Text (14):
The above object is achieved in accordance with the principles of the present invention in a gradient coil assembly for an NMR tomography apparatus including at least one gradient coil and at least one cooling structure, the cooling structure including at least one flexible cooling conduit for conducting a cooling medium, this conduit being flexibly attached to a flexible carrier. The gradient coil is also connected to the flexible carrier.

Brief Summary Text (15):
The invention has its basis in the provision of a flexible carrier for at least one cooling conduit which is also flexible. In an optimal arrangement, the cooling conduit can be comfortably assembled on the carrier, and thereafter, one or more complete cooling structures are combined into the gradient coil assembly, together with one or more gradient coils. The inventive gradient coil assembly thus can be prepared in a cost effective manner without having to sacrifice good cooling properties. Moreover, the carrier forms an additional electrical insulator.

Brief Summary Text (16):
The connection points between the cooling conduit and the carrier are also inventively flexible. The flexibility of the cooling structure is particularly good by means of this measure, because relative motion between the conduit and the carrier is made possible. Additionally, a cooling conduit flexibly attached to the carrier can be modified as to its position for fine adjustment.

Brief Summary Text (17):
A flexible cooling structure either can be attached to a flat gradient coil or to a non-planar gradient coil, with the cooling structure preferably being fitted to the shape of the gradient coil in order to enable a good thermal contact. The gradient coil can be curved in one direction (e.g. cylindrically or in the shape of an envelope of a cone) or in a number of directions.

Brief Summary Text (18):
In order to obtain a good cooling effect, a liquid coolant preferably serves as a cooling medium, for example water, oil, or a water/oil mixture.

Brief Summary Text (19):
The cooling structure is preferably constructed initially in a flat state. This is particularly comfortable and permits the utilization of a winding form for the cooling conduit. The carrier also can be prestressed to the approximate later shape of the curve during the attachment of the cooling conduit.

Brief Summary Text (20):

The flexible connection between the cooling conduit and the carrier preferably ensues by a seam which is sewn with an elastic thread or with some play between the thread loops and the cooling conduit, for example. Alternatively the cooling conduit can be glued onto the carrier by an elastic glue in a puncti-form fashion. A relatively rigid connection between carrier and cooling conduit can also be used if this connection is limited to those points which shift only a small amount, if any, when the cooling structure is fitted to the shape of the gradient coil.

Brief Summary Text (21):
In a preferred embodiment, the cooling conduit consists of a plastic pipe, of polyamide (PA) or polyethylene (PE), for example. In principle, a conduit of sufficiently soft metal, for example copper, could also be used. Such a conduit would in fact have a lower heat transmission resistance; however, due to eddy currents, problems would result due to the need for electrical insulation and with regard to its ductility.

Brief Summary Text (22):
The cooling conduit is preferably constructed as one piece, i.e. free of separation points (joints). Thus, there are no connection pieces (for example angle pieces or U-pieces) provided in the cooling conduit. Such a cooling conduit is reliably tight over a long lifetime. Moreover, problems associated with narrow curve radii of connection pieces are avoided.

Brief Summary Text (23):
The cooling conduit is preferably conducted in a bifilar fashion; that is, in the form of an extended loop whose point of reversal is arranged approximately in the center of the conduit length and whose two legs proceed next to each other with opposing flow directions. Thus the temperature gradient is balanced over the length of the conduit, and a more uniform cooling effect is achieved. Moreover, in a bifilar arrangement, the advance and return of the cooling conduit lie approximately adjacent, so that the outlay for the outer tubing is low.

Brief Summary Text (24):
The cooling conduit can be conducted in a spiral or a serpentine shape. The cooling conduit path preferably fits the spatial distribution of the cooling demand. The wall thickness of the cooling conduit is preferably appropriately selected dependent on the desired heat transition value, the pressure of the cooling medium, and the desired electrical insulation properties.

Brief Summary Text (25):
Thee cooling structure preferably includes a number of cooling rings which can be connected in parallel. The pressure loss is thus kept down, the rate of flow amount is increased, and redundant paths are made available. The cooling rings can each have separate coolant terminals. Then individual cooling rings can be switched into and out of the cooling "circuit" according to the momentary cooling demand.

Brief Summary Text (26):
The carrier is preferably formed from a non-magnetic plastic or composite material, for example, from a laminated plastic plate, a glass-fiber reinforced plate, or a suitable plastic plate. The carrier only needs to be flexible enough so that it can be brought into the described shape. The thickness of the carrier is selected dependent on the desired heat transition value and the electrical insulation properties.

Brief Summary Text (27):
Securing elements or assembly elements for at least one other structural element are preferably constructed or attached at the carrier. This other structural element can be another gradient coil which is secured to the side of the carrier opposite the cooling conduit.

Brief Summary Text (28):
In a preferred embodiment the gradient coil(s) and the cooling structure are cast with a suitable casting compound, for example, with a filled epoxy resin, in order to form the gradient coil assembly. If the casting compound is hardened at higher temperatures (e.g. 120.degree. C.), the structural elements of the cooling structure must be produced from sufficiently temperature-resistant materials. A substantially rigid assembly is created by the casting. In this case, the flexibility of the carrier and of the cooling conduit simplifies the production of the gradient coil assembly and moreover leads to a lower mechanical load in operation, because different heat capacities of the individual structural elements are balanced.

Brief Summary Text (29):
In a gradient coil assembly with a number of gradient coils, a number of cooling structures is preferably provided, possibly alternating in different layers with the gradient coils.

Brief Summary Text (30):
A winding form is preferably used in the inventive production method, in order to give the cooling conduit a course which is matched to the cooling requirements.

Brief Summary Text (31):
The production of the gradient coil assembly is particularly cost-effective if a gradient coil is first made available on a winding spindle, then the cooling structure is attached to this gradient coil, with another gradient coil then (if desired) being attached at assembly elements of the cooling structure, and all the aforementioned structural elements are cast at once, and finally, the winding spindle is withdrawn from the thusly formed gradient coil assembly.

Drawing Description Text (5):
FIG. 4 is a sectional illustration of a region of a tubular gradient coil assembly constructed in accordance with the invention.

Detailed Description Text (2):
The cooling structure 10 depicted in FIGS. 1 to 3 includes a flexible carrier 12 constructed as a somewhat quadratic, flat plastic plate. Two cooling conduits 14, 14' are arranged in a spiral shape on one side of the carrier 12, these conduits being connected to the carrier 12 by flexible seams 16.

Detailed Description Text (3):
The two cooling conduits 14, 14' are constructed as flexible plastic conduits of polyamide (PA). They are arranged in a bifilar fashion, i.e. as oblong loops, wherein the two legs of such a loop are arranged adjacently with opposing flow directions of a cooling medium therein, respectively. The center of each cooling conduit 14, 14'--i.e. the reversal point--is arranged in the middle of the carrier 12 in the shape of an "S". The cooling conduits 14, 14' are formed as one piece and thus free of separation and connection points.

Detailed Description Text (4):
The cooling conduit 14 has two terminals 18 which serve as inlet and return terminals and are adjacently arranged at the edge of the carrier 12. The cooling conduit 14' is correspondingly provided with two terminals 18'. The cooling conduits 14, 14' can be connected to a cooling system of the NMR tomography apparatus via the terminals 18, 18', this cooling system pumping the cooling medium, e.g. water, through the cooling conduits 14, 14'.

Detailed Description Text (5):
In the exemplary embodiment described herein, the cooling conduits 14, 14' cover the carrier 12 approximately uniformly over its entire surface. There are gaps only in the middle of the carrier 12 (near the reversal points of the cooling conduits

14, 14', which points require a certain amount of space due to the limited bending radius of the cooling conduits 14, 14') and at four securing holes 20. This exemplary embodiment of the cooling structure 10 thus is suitable for applications in which the heat to be conveyed away is removed approximately uniformly. In alternative embodiments, the conduit format can have tighter and less tight regions in order to fit the cooling effect to various heat output zones.

Detailed Description Text (6):
The seams 16 are attached at the carrier 12 parallel to its side edges, in order to hold the cooling conduits 14, 14' on the carrier 12 in a flexible manner. A few of the seams 16 are led from the middle of the side edges of the carrier 12 to the midpoint of the carrier 12, while other seams 16 are arranged only in one edge region of the carrier 12. Each seam loop surrounds a cooling conduit 14, 14' in a loose fashion and runs through the carrier 12.

Detailed Description Text (7):
At the side of the carrier 12 facing away from the cooling conduits 14, 14' assembly elements 22 are glued on, at which a further gradient coil can be attached, for example.

Detailed Description Text (8):
In the exemplary embodiment of a gradient coil assembly shown in FIG. 4, two gradient coils 24, 24' designed in tubular fashion include a cooling structure 10 which is fitted in its shape to the curve of the gradient coils 24, 24'. The inner gradient coil 24 is constructed as a saddle coil in order to create a magnetic field gradient in the x-direction. A further inner gradient coil, which is arranged displaced 90.degree. relative to the gradient coil 24 and which creates a magnetic field gradient in the y-direction, is not shown in FIG. 4. The outer gradient coil 24' has two ring-shaped windings and serves for creating a gradient in the z-direction.

Detailed Description Text (9):
In the arrangement according to FIG. 4, the cooling conduits 14, 14' face the inner gradient coil 24, while the outer gradient coil 24' is secured at the assembly elements 22. Adjustment pins are incorporated in the gradient coil 24 and run through the holes 20 of the carrier 12. The whole assembly is cast with a filled epoxy resin.

Detailed Description Text (10):
For the production of the assembly according to FIG. 4, a cylindrical winding spindle (mandrel) is first made available. The gradient coil 24 for the gradient in the x-direction, as well as the further inner gradient coil for the gradient in the y-direction, are arranged thereon. Appropriate adjustment pins are placed in the gradient coils.

Detailed Description Text (11):
A sufficient number of cooling structures 10 are simultaneously produced. For each cooling structure 10, two cooling conduits 14, 14' are laid in respective grooves of a winding form, so that the cooling conduits 14, 14' are held in the winding form in their later course. The winding form is now placed on the still flat carrier 12, and the cooling conduits 14, 14' are sewn to the carrier 12 in a flexible fashion through oblong holes in the winding form. Now the winding form can be removed.

Detailed Description Text (12):
As the next step, the flat, flexible cooling structure 10 is bent corresponding to the curve of the gradient coils already located on the winding spindle, and the cooling structure 10 is placed onto the adjustment pins with the pins extending through securing holes 20 therein, with the cooling conduits 14, 14' facing these gradient coils. When the entire outer surface of the inner gradient coils is

covered by the cooling structure 10, the gradient coil 24' is secured at the assembly elements 22. The whole assembly, still located on the winding spindle, is cast in a suitable form with a filled epoxy resin. Following the hardening of the resin at approximately 120.degree. C., the winding spindle is withdrawn from the finished gradient coil assembly.

CLAIMS:

1. A gradient coil assembly for use in an NMR tomography apparatus, comprising:

a gradient coil;

a flexible cooling conduit for containing a flowing coolant for conveying heat away from said gradient coil during operation of said gradient coil;

a flexible carrier;

means for flexibly connecting said cooling conduit to said flexible carrier; and

means for connecting said flexible carrier to said gradient coil.

2. A gradient coil assembly as claimed in claim 1 wherein said means for flexibly connecting said flexible cooling conduit to said flexible carrier comprises a flexible sewn seam.

3. A gradient coil assembly as claimed in claim 1 wherein said means for flexibly connecting said flexible cooling conduit to said flexible carrier comprises a flexible glue.

4. A gradient coil assembly as claimed in claim 1 wherein said flexible cooling conduit comprises a plastic pipe.

5. A gradient coil assembly as claimed in claim 4 wherein said plastic pipe comprises a continuous pipe free of joints.

6. A gradient coil assembly as claimed in claim 1 wherein said flexible cooling conduit is disposed on said flexible carrier in bifilar fashion.

7. A gradient coil assembly as claimed in claim 1 wherein said carrier comprises a non-magnetic material selected from the group consisting of non-magnetic plastic and non-magnetic composite materials.

8. A gradient coil assembly as claimed in claim 1 further comprising at least one assembly element attached to said carrier for holding a further structural element to said carrier.

9. A gradient coil assembly as claimed in claim 1 further comprising a casting compound covering said gradient coil, said flexible carrier and said flexible cooling conduit.

10. A gradient coil assembly as claimed in claim 9 wherein said casting compound comprises a filled epoxy resin.

11. A gradient coil assembly as claimed in claim 1 wherein said gradient coil is curved in at least one direction, and wherein said flexible cooling conduit is matched to a curve of said gradient coil.

12. A method for producing a gradient coil assembly for an NMR tomography apparatus, comprising the steps of:

providing a gradient coil;

providing a flexible cooling conduit for conveying a flowing cooling medium;

providing a flexible carrier;

flexibly attaching said cooling conduit to said flexible carrier to produce a cooling conduit/carrier combination; and

attaching said cooling conduit/carrier combination to said gradient coil.

13. A method as claimed in claim 12 wherein said gradient coil has a non-planar shape, and wherein the step of providing said flexible cooling conduit comprises providing said flexible cooling conduit initially in a flat state and subsequently fitting said flexible cooling conduit to said non-planar shape of said gradient coil.

14. A method as claimed in claim 12 comprising the additional step of placing said cooling conduit in a winding form; and

attaching said cooling conduit in said winding form to said flexible carrier.

16. A method as claimed in claim 12 comprising the additional step of making said gradient coil available on a winding spindle;

attaching said flexible conduit to said gradient coil while said gradient coil is on said winding spindle;

casting at least said gradient coil and said flexible conduit in a casting resin simultaneously; and

removing said winding spindle.

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L36: Entry 12 of 13 File: USPT Sep 10, 1996

DOCUMENT-IDENTIFIER: US 5554929 A
TITLE: Crescent gradient coils

Abstract Text (1):
A high-conductivity ceramic coil form with an internal water jacket is used to simplify water cooling for 3-axis MRI gradient coil configurations on a single cylindrical coilform. Crescent-shaped, axially aligned coils are symmetrically employed on either side of the axial symmetry plane to increase transversely the region of field linearity. These crescent coils may be used in conjunction with Golay-type coils for improved switching efficiency. Lead-filled copper tubing may be used to reduce acoustic noise from pulsed coils in high external magnetic fields.

Brief Summary Text (2):
The field of this invention is electromagnetic coils for the purpose of efficiently generating gradients, especially in magnetic resonance imaging (MRI) and other gradient techniques employing a superconducting magnet.

Brief Summary Text (4):
Most modern MRI systems use a superconducting solenoid to establish a uniform B.sub.O (or B.sub.Z) over the imaging volume. This results in the magnetic field being collinear with the path available for sample access. Coils are then required to produce monotonic, (preferably linear) gradients in B.sub.Z with respect to x, y, and z over the sample region during precisely determined pulse sequences. The transverse gradients (.delta.B.sub.Z /.delta.x, .delta.B.sub.Z /.delta.y) in the prior art have generally been established by symmetrically located sets of saddle coils, similar to those first described by Golay in U.S. Pat. No. 3,569,823 or by related planar coils as disclosed by Roemer, U.S. Pat. No. 4,926,125 and Morich et al, U.S. Pat. No. 5,036,282. Maxwell pairs or related geometries are universally used to generate the axial gradient. A co-pending application, Ser. No. 07/912,149, discloses the use of coil geometries more complex than surface currents to achieve order-of-magnitude improvements in several critical parameters for transverse gradient coils: acoustic noise and DC gradient efficiency.

Brief Summary Text (5):
The instant application discloses (a) the combined use of Golay-type and crescent-coil geometries for greatly improved switching efficiency and (b) the convenience of internal water cooling with transverse gradients. The closest prior art to the instant invention, in terms of magnetic field configuration, appear to be the trapezium loops for use with an electromagnet, as disclosed in the article "Magnetic Field Gradient Coils for NMR Imaging" by Bangert and Mansfield in Journal Physics, E, 15, 235 (1982), some screening concepts disclosed by Mansfield in U.S. Pat. No. 4,978,920, and the above referenced co-pending patent application.

Brief Summary Text (6):
The gradient pulses induce eddy currents and vibrations in nearby conducting structures (especially in flimsy shields, in the cryostat, and in lightweight rf coils) which perturb the field homogeneity following the pulses with time and spatial dependencies that are not easily characterized. Actively shielded coils for MRI were first publicly disclosed by Mansfield in February 1986 at approximately

the same time that Roemer filed the patent application which resulted in U.S. Pat. No. 4,737,716. Prior independent work was underway at Doty Scientific, which shipped the first such commercially available NMR gradient coils in January 1987. Actively shielded dipolar coils for energy storage were previously disclosed by Westendorp, U.S. Pat. No. 3,671,902. Actively shielded, constant-gradient, quadrupolar magnetic field coils based on cylindrical current sheets for atomic beam confinement and focusing were previously disclosed by Beth, U.S. Pat. No. 3,466,499.

Brief Summary Text (7):
FIG. 1 approximately depicts the fingerprint coils of Schenck, Hussain, and Edelstein, U.S. Pat. No. 4,646,024, as used to generate .delta.B.sub.Z /.delta.y in an imaging region in the sample. Such a pattern achieves both higher linearity and higher switching efficiency than first-order Golay coils A similar set of concentric coils rotated 90.degree., is used to generate .delta.B.sub.z /.delta.x.

Brief Summary Text (8):
The major gradient design problems center on the following: (1) limited available space because of economic considerations, (2) motion-induced artifacts arising from the finite stiffness and mass of the coil support structure, (3) practicable coil winding (or etching) techniques, (4) acoustic noise abatement, (5) heat dissipation, and (6) minimization of transverse field components.

Brief Summary Text (9):
The conflicting technical requirements may be partially addressed by means of local planar gradient coils with highly nonlinear response, as disclosed by Roemer, U.S. Pat. No. 4,926,125. By adding distortion correction algorithms to the image processing, it is possible to use gradients with .+-.40% to .+-.60% non-linearity on one axis in applications where high spatial resolution is required only over a small portion of the image.

Brief Summary Text (10):
The following parameters generally need to be specified for gradient coil systems: gradient coefficient .alpha. (T/Am) (sometimes called gradient efficiency in the prior art), imaging sphere diameter d.sub.i (m) for a specified linearity deviation, inductance L (H), resistance R.sub.E (.OMEGA.), maximum continuous power dissipation P (W), maximum pulse current I.sub.P (A) in a specified B.sub.O, recovery time T.sub.D (s) for a specified pulse, acoustic noise for a specified pulse sequence in a specified field, and ratio of transverse field energy in the sample region to axial field energy in the imaging region.

Brief Summary Text (11):
For the fastest imaging technique, Echo Planar Imaging (EPI) and related techniques, the most important parameters are recovery time, gradient switching efficiency, transverse fields, and acoustic noise. Although EPI was first described more than 15 years ago, it has seldom been used because prior art gradient coils (a) may require megawatts of gradient driver power on the frequency-encoding axis, (b) generate sound pressure levels that are painful and damaging to the patient's hearing, (c) produce motion-related artifacts that cannot be fully removed even with the most sophisticated image postprocessing, and (d) require high power audio amplifiers costing up to several million dollars. A recent experimental demonstration at 0.5 T required nearly half a megawatt (at 10% duty cycle) at 1 kHz, and others have proposed the use of 2 MW at 5 kHz, 1.5 T, and 50% duty cycle for slice-interleaved EPI techniques. The above problems may be partially addressed using a tuned transverse gradient with sinusoidal (monochromatic) current; but the conventional gradient coil has very low electrical Q; and there are penalties in SNR and heat dissipation. Also, computational analysis becomes more complex, but the software is available.

Brief Summary Text (12):

While the Maxwell z-gradient is considerably more efficient than the Golay transverse gradient, the frequency-encoding gradient must be in the plane of the image, which often must be transverse for medical reasons. Therefore, improvements are needed in transverse gradients.

Brief Summary Text (14):
It should be pointed out that there is ambiguity in the definition and usage of the term "linearity" in the MRI gradient literature. Henceforth, we use this term to indicate the rms deviation of local field slope compared to the mean field slope over a specified volume. This definition is generally more demanding and a better indicator of image quality than the more common definition where linearity is defined as the maximum gradient field deviation relative to a linear field at any point in the sample, as the latter definition averages local fluctuations along the gradient axis. Other definitions can be less demanding and less useful.

Brief Summary Text (15):
The availability of better image processing and distortion correction techniques suggests that the rms gradient deviation a be increased to 14% compared to the more typical 10% value for many prior art gradients, to increase imaging volume. It is still important that the field be monotonic, but the method of Schenck et al in U.S. Pat. No. 4,646,024 results in relatively poor switching efficiency, intolerable acoustic noise, and unmanageable motion-related artifacts.

Brief Summary Text (16):
The enormous bandwidth (several MHz) of high-resolution EPI (and other more advanced techniques) can reduce the imaging time by two or three orders of magnitude without placing unrealistic demands on modern computers since computational power per cost has increased at the rate of 40% per year for the past seven years and that rate is expected to continue for several more years. Designing for strong gradients with larger gradient non-linearity with very fast switching places increased (though inconsequential) computational demands on the image processing. While there may be some increased variation in SNR over the final image, this is more than offset by the increased data rate.

Brief Summary Text (17):
In practice, using conventional shielded gradient coils, the inductive energy (I.sup.2 L/2) is larger than suggested by simple energy estimates by a substantial factor. In a co-pending patent application, methods are disclosed that allow increases in .alpha..sup.2 /L by factors of 2 to 10 compared to prior art Golay coils. However, for large systems the most important efficiency figure-of-merit often is .eta..sub.s =.alpha..sup.2 d.sub.i.sup.4 h.sub.i /.mu..sub.O L where h.sub.i is the imaging region field-of-view in the axial direction. The instant invention allows increases in .eta..sub.s by factors of 2 to 20 compared to prior art.

Brief Summary Text (18):
Some prior gradient coil designs have also suffered under the false notion that there is an inherent advantage with very low inductance coils. Higher inductance (more turns) requires higher voltage, but not higher power (VA) for the same switching time. In fact, reducing inductance below 100 .mu.H is detrimental as lead inductance and transmission line problems then becomes significant. Coil orthogonality (for isolation) and net force cancellation both dictate that integral number of turns be used in all coil sets and coil subsets. Hence, the accuracy of the shielding is limited from this quantization. The more turns, the more precisely the gradients can be shielded. Optimum number of turns is thus determined largely by the VA characteristics and economics of available power devices, magnetic shielding accuracy requirements, and standard wire insulation practice, making 250 V to 800 V (peak differential voltages for a balanced line) at 20 A to 300 A best for large systems. Optimum inductance is typically 0.2 to 1 mH.

Brief Summary Text (20):
A high-conductivity ceramic coil form with an internal water jacket is used to simplify water cooling for 3-axis MRI gradient coil configurations on a single cylindrical form. Crescent-shaped, axially aligned coils are symmetrically employed on either side of the axial symmetry plane to increase transversely the region of field linearity. These crescent coils may be used in conjunction with Golay-type coils for improved switching efficiency. Lead-filled copper tubing may be used to reduce acoustic noise from pulsed coils in high external magnetic fields.

Drawing Description Text (2):
FIG. 1 illustrates the prior-art, shielded, fingerprint, transverse gradient coil in the spherical coordinate system;

Drawing Description Text (3):
FIG. 2a-2c disclose a tapered crescent coil with two parallel windings of lead-filled copper tubing;

Drawing Description Text (4):
FIGS. 3a and 3b illustrate a method of winding a coil on a coilform that has a concave surface;

Drawing Description Text (5):
FIGS. 4a and 4b disclose a transverse gradient coil system using a Golay coil and three axially oriented crescent coils on each side;

Drawing Description Text (6):
FIG. 5 depicts the use of an internal water cooling jacket;

Drawing Description Text (7):
FIGS. 6a and 6b illustrate a preferred 3-axes gradient coil assembly with an internal water cooling jacket;

Drawing Description Text (8):
FIG. 7 is a schematic representation of a method of connecting parallel windings to achieve orthogonality;

Drawing Description Text (9):
FIG. 8 is a schematic representation of a method of achieving orthogonality using gradient coils with shared windings;

Drawing Description Text (10):
FIG. 9 is a cross section of an X-Y gradient coil system using a Golay coil and twelve axially oriented crescent coils;

Drawing Description Text (11):
FIG. 10 is a schematic representation of a method of orthogonally powering 12 crescent coils with shared windings; and

Detailed Description Text (2):
Qualitative comparisons of various gradient coil geometries of different sizes are often misleading because of the complex expressions for power, inductance, resistance, and gradient coefficient and the varying degrees of sensitivity to coil motion. For example, power is often proportional to the radius to the fifth power for constant winding thickness and voxel size, but power is often linear with radius for constant number of voxels and constant relative winding thickness, depending on the relative significance of .gamma.Gd.sub.i T.sub.2 and SNR (signal to noise ratio) in the determination of spatial resolution. Here, .gamma. is the magnetogyric ratio, G is the magnetic field gradient (T/m), d.sub.i is the imaging diameter, and T.sub.2 is the spin-spin relaxation time (s). Thus, it is useful to develop dimensionless figures of merit for comparison of various gradient coil

systems of various sizes.

Detailed Description Text (3):
We define a switching figure-of-merit, or switching efficiency, .eta..sub.s : ##EQU1## where .alpha. is the gradient coefficient (T/Am), d.sub.i is the imaging diameter for 14% rms gradient deviation .sigma., h.sub.i is the axial imaging length for the same deviation, .mu..sub.O is the permeability of free space, and L is the inductance. The above definition differs from a previously derived definition by a constant, making it more conveniently expressed as a percent. For a typical ellipsoidal imaging region, it has numeric value between 1% and 20% for shielded Golay coils and 15% to 90% for shielded Maxwell pairs and quadrupolar coils for use in magnets with transverse B.sub.O.

Detailed Description Text (4):
Prior-art fingerprint coils as shown in FIG. 1 have typical .eta..sub.s of 10% to 30%, depending primarily on the shielding ratio to gradient radii. The crescent-Golay geometry disclosed in the current application achieves .eta..sub.s of 20% to 90%.

Detailed Description Text (5):
It should be noted that the gradient field produced by Golay or fingerprint coils is predominately in the radial direction near window 101, positioned close to polar angle .theta. of 45.degree.. This transverse component is of no imaging value, but it is responsible for the majority of the currents induced in the sample, which are to be minimized for patient safety reasons. Largely for this reason, and to enhance rf efficiency, it is not practical for d.sub.i to exceed 1.7r.sub.g, where r.sub.g is the gradient coil radius, as the induced currents increase rapidly for larger values of d.sub.i.

Detailed Description Text (6):
Next we define a low frequency (LF) electrical efficiency .eta..sub.L : ##EQU2## where the constant has the units m/s as indicated. This definition differs from an earlier definition by a constant factor, primarily for convenience. This LF efficiency evaluates to 2.5% for a typical prior-art transverse coil designed for d.sub.i =84 mm (the copper thickness was about half the skin depth) but values below 1% are typical for large planar transverse gradient coils. Typical values for Maxwell-pairs are near 10%, and there is usually little justification for higher LF efficiency, although values above 40% can be achieved for transverse gradients with octopolar geometries of the co-pending application and crescent-Golay systems of the current application.

Detailed Description Text (7):
The figure of merit governing coil power dissipation during EPI is Q.eta..sub.s, but the electrical Q at the switching frequency (e.g., 1600 Hz) cannot easily be determined, except by experimental measurement. The electrical Q is generally proportional to coil volume and the square root of frequency. For shielded whole-body coils at 1600 Hz it is typically 3 to 30.

Detailed Description Text (8):
Optimum conductor thickness in the fingerprint coil in regions where the gradient field is predominately axial is approximately one skin depth (typically 3 mm for copper) at the EPI switching frequency. However, optimum thickness in the vicinity of the window, where large radial components are present, is greater.

Detailed Description Text (9):
Coil motion is one of the most troublesome design limitations in many prior art gradient coils. Golay-type transverse gradient coils in a uniform external magnetic field develop opposite torques which cause the cylindrical coilform to bow in the plane of the z-axis and the desired gradient. The governing equations change radically depending on whether most of the energy in the gradient pulse spectrum is

below or above the fundamental mechanical mode to which it is strongly coupled.

Detailed Description Text (10):
We define a high-frequency electro-mechanical efficiency .eta..sub.mh, (which we want to minimize) as the ratio of mechanical energy in the coils to magnetic energy in the sample and show that for conventional Golay coils it is approximately as follows:

Detailed Description Text (11):
where t.sub.g is the gradient pulse length (s), s is the ##EQU3## difference between the shield coil radius and the gradient coil radius (m), and m.sub.c is the Golay coil mass per quadrant (kg). Clearly, relative mechanical energy during short pulses (electrical excitation frequency high compared to mechanical resonances) is minimized by increasing .eta..sub.s, s, and m.sub.c for a given B.sub.0 and t.sub.g. Since m.sub.c would be expected to increase as the second or third power of r.sub.g, it might appear that motion-related problems are reduced by increasing r.sub.g. However, t.sub.g (if inversely proportional to the gradient field strength, B.sub.G) will generally increase as the second, third, or even fourth power of r.sub.g in large coils, depending on the severity of acoustic noise and the amount of power that can be justified. Thus, electro-mechanical efficiency in the short-pulse limit typically increases with r.sub.g because the pulse lengths must increase. For the Golay-crescent geometry of the instant invention, the constant in the denominator is increased by a factor of four.

Detailed Description Text (13):
The co-pending patent application Ser. No. 07/912,149 discloses the mechanical advantages of small-diameter, solenoidal-like trapezoidal coils external to the imaging region for reducing acoustic problems. By increasing the stiffness, it is then possible to stay below resonance for the strongest couplings, and motion problems are easily eliminated. Also, the trapezoidal coil structures can achieve higher switching efficiency but linearity is inferior unless novel winding densities similar to those of the instant invention are used. The co-pending patent application also discloses that improved switching efficiency and improved shielding can be obtained by interleaving Golay-type coils with trapezoidal solenoidal coils.

Detailed Description Text (14):
According to equation [3], coilform stiffness is not a factor above resonance. Mechanical energy is decreased by simply increasing the mass of the coil. Hence, lead-filled copper tubing can be advantageous when the driving frequency is greater than a mechanical resonance. However, there will always be circumstances in which the coils are driven below mechanical resonance. Thus, it is desirable to mount massive conductors on stiff coilforms so that mechanical efficiency is poor at both low and high frequencies.

Detailed Description Text (15):
A simple method of quantifying shielding effectiveness is to define flux leakage .PHI..sub.L as the relative change in inductance when a passive cylindrical shield is added at radius r.sub.s, the radius of the radiation shields in the cryomagnet. This radius will typically be 1.2(r.sub.g +s). ##EQU4##

Detailed Description Text (17):
FIG. 2 discloses the crescent coil of the instant invention, which allows substantial improvements in switching efficiency, linearity, and shielding when used with Golay-type coils, especially when s is small compared to r.sub.g. Moreover, these improvements are achieved without significant increase in acoustic noise compared to the solenoidal geometries. The thick-walled, crescent coilform 201 is made of a high-modulus, non-magnetic material of high electrical resistivity such as glass-filled polyphthalamide (PPA) or a sialon. The crescent coilform 201 comprises a cylindrical concave surface 202, a cylindrical convex surface 203,

radial surfaces 204, 205, and end surfaces 206, 207. The two cylindrical surfaces are concentric and subtend similar azimuthal angles .omega. with respect to a common axis 208, but the convex surface 203 will typically have greater axial length than that of the concave surface 202 and may subtend a somewhat larger or smaller azimuthal angle .phi.. The radial surfaces and end surfaces 204, 205, 206, 207 are trapezoidal in shape and may be inclined with respect to the radial direction. The radial surfaces may be slightly convex to facilitate coil winding. The axially oriented edges 211, 212, 213, 214 are radiused to simplify coil winding, and grooves 215 and lips 216 may be added to the arcuate and radial surfaces for the same purpose.

Detailed Description Text (18):
Two parallel coil windings 220, 221 are shown as would be required in some cases, but single windings and multiple-layer windings would often be preferred. For moderately large systems, lead-filled copper tubing may be used for the conductor elements, where each conductor 220, 221 is filled with lead 222. The increased density of Pb is beneficial in reducing acoustic noise and vibrations of the low-frequency transverse modes, according to equation [3]. In very large systems, the radial modes of the crescents could be more troublesome, in which case aluminum strip or tubing would be preferred for the windings. Always, the windings would be securely bonded to the crescent coilform, preferably using a fiber-reinforced thermosetting material, such as epoxy or polyester 223. The crescent is symmetric with respect to a reflection through a plane 224 containing an internal coilform axis.

Detailed Description Text (19):
Novel fixturing is required to wind a coil on a coilform with a concave surface. The technique illustrated in FIGS. 3a and 3b attaches a cylindrical convex-convex spacer 301 to the concave surface 203 that can be removed by etching, melting, dissolving, disassembly, or mechanical machining after the coil is wound. The convex winding elements 323 near the concave surface may then be bent inward and bonded to the concave surface 202. The optimum winding density will always be higher on the concave surface than on the convex surface 203, and it will often be desirable to use two layers on the concave surface and a single layer on the convex surface, which may require a separate winding fixturing operation for each layer. For very large crescent coils, a more convenient approach than winding may be to solder individual segments of properly curved strips or tubing together. Then, different conductor element sizes can be used on the different surfaces.

Detailed Description Text (20):
Another method of producing the required winding on a concave surface would be to start by coating the entire external surface of the crescent coilform with copper film by sputtering, chemical vapor deposition, chemical precipitation, or any other suitable technique. A polymer resist can then be applied and developed by conventional screening or photochemical processes to permit etching of the desired winding or windings. The copper windings can then be electrochemically plated to the desired thickness.

Detailed Description Text (21):
FIG. 4 depicts a thin-walled, nonmetallic, cylindrical coilform 401 of approximate outer radius r.sub.g on which a hybrid y-gradient (.delta.B.sub.z /.delta.y) coil assembly of the instant invention is mounted. The hybrid coil assembly subtends azimuthal angle .phi..sub.T greater than 110.degree. and less than 150.degree., on each side of the x-z plane Golay coil 410 has first azimuthal members 411 at mean polar angle .theta..sub.1 between 48.degree. and 60.degree. and second azimuthal members 412 at mean polar angle .theta..sub.2 less than 42.degree.. In FIG. 4, Golay coil 410 appears twice, once in plain view at the left of coil form 401, and again in phantom behind the coil form 401. The latter is shown with its upper winding portions (azimuthal members) 412 and with lower winding portions. The upper winding portions have a center which defines polar angle .theta..sub.2, shown in

phantom when obscured by coil form 401 and by part of winding portions 412. The lower winding portions, which mirror region 411 in the figure, have a center which defines polar angle .theta..sub.1.

Detailed Description Text (22):
Six symmetrically y located crescent coils 420, 430, 440, and their symmetric counterparts on the -y side, are used in place of the solenoidal coils of the co-pending patent application Ser. No. 07/912,149.

Detailed Description Text (23):
The crescents have concave conductor elements 421 at approximate radius r.sub.g, convex conductor elements 422 at approximate radius r.sub.g +s, and radial conductor elements 423 therebetween.

Detailed Description Text (25):
The axial length h.sub.1 on the concave side of the crescents (See FIG. 2) is greater than r.sub.g /2 and less than 1.5r.sub.g. The axial length h.sub.2 on the convex side of the crescents is greater than 1.2h.sub.1 but less than 2.5h.sub.1. Numerical integration of the Biot-Savart law may be used to optimize windings for various values of s/r.sub.g and various optimization criteria. The surface current density on the concave side of the center crescent is typically about 40% greater than that on the diagonal crescents. Surface current densities on the convex sides of the crescents are typically lower near their ends than near the center. Surface current densities on the concave sides of the crescents are often 20% higher near their ends than near the center. Surface current densities in the Golay coils are typically about 20% higher than the highest current densities in the crescents.

Detailed Description Text (26):
Since the crescent conductor elements form complete loops and are symmetrically inclined with respect to the uniform external field B.sub.O, there are no net Lorentz forces or torques on the center-of-mass of any of the crescents to first order. Thus, it is not necessary to be concerned about torsional or positional rigidity of the crescents in the gradient assembly. It is sufficient that the crescent coilforms be made of a material of high modulus to insure that the radial-mode mechanical resonances in the crescents are not excited. The crescents may then be precisely secured in position by epoxy bonding the concave surfaces of the crescents to the surface of the cylindrical coilform 481 without undue concern about rigidity of this cylinder. The elastic modulus of coilform 401 can be as low as 3 GPa in some cases, but elastic modulus above 200 GPa would be preferred for large systems in high B.sub.0 to minimize motion-related problems from the Golay coils at low frequencies.

Detailed Description Text (27):
Forced air cooling over the surfaces of the crescents and Golay coils will often provide sufficient cooling, but in some applications additional cooling will be required. FIG. 5 depicts an effective method of achieving higher power density by providing the benefits of water cooling with fewer of the electrical isolation and plumbing problems associated with conventional water cooling methods. (One prior art technique is to bond plastic plumbing to the surface of the fingerprint coils. Another prior-art technique is to hermetically coat all conductors and then flood the coil assembly with water. Another prior art technique is to use copper tubing for the coils and circulate deionized water directly through the live windings.) The thin-walled coilform 401 is made from a material having high thermal conductivity and high strength, preferably silicon nitride, or alumina, or an alumina-filled composite. An inner thin-walled cylinder 501 of inner radius r.sub.1 and outer radius r.sub.2 is used to establish an internal cooling water jacket. O-rings 502, 503 may be used for compliant sealing, and plastic plumbing 504 can be used to circulate water through the annular space between the concentric cylinders. The Golay coil 410 bonded to the outer surface of the coilform is easily cooled by conduction. The crescents 420, 430, 440 are well cooled on their concave surfaces,

and the high thermal conductivity of the heavy copper windings will usually conduct sufficient heat for adequate cooling of the other surfaces of the crescents. Both forced air cooling and water cooling may be used, allowing more flexibility in the use of the coils. The use of high-modulus, high-strength materials, allows the total relative thickness, (r.sub.g -r.sub.1)/r.sub.g, to be less than 0.1.

Detailed Description Text (28):
It will normally be desirable to mount the X, Y, and Z gradients on a single coilform of approximate radius r.sub.g as shown in a perspective view in FIG. 6a and in a cross section of the plus-plus quadrant of the yz plane in FIG. 6b. Note that x-Golay coil 610 and y-Golay coil 615 overlap and that diagonal crescents 620, 630, 640 are used for both the x and y axes. The x-Golay coil 610 and the y-Golay coil 615 are essentially identical except that one is positioned at .phi.+90.degree. relative to the other. Clearly, one is also at a slightly larger radius; the z position may also be shifted slightly. Conventional, corrected Maxwell pairs 660 are wound over the Golay coils for the z gradient. The internal water jacket 505 effectively cools all of the windings. Some simplification in the winding of the outer Golay coil (and perhaps some improvement in the cooling of the outer Golay coil) may be obtained by adding spacer material 611, equal in thickness to that of the inner Golay coil, to the surface of the coilform 401 beyond the azimuthal extent of the inner Golay so that the outer Golay has a substantially smooth, cylindrical surface on which to be mounted. For best heat transfer without eddy current problems, this spacer material would consist of a large number of open-ended segments of copper wires.

Detailed Description Text (29):
Optimum positions of external shielding coils 661 for the quadrupolar z-gradient may be determined by the method of Beth, U.S. Pat. No. 3,466,499, or by numerical application of the Biot-Savart law, or by other well-known methods. The octopolar fields produced by the Golay-crescent transverse gradient coils have extremely low external fields, but further shielding Golay coils 616 may still be desired. (Note that these coils are not shown in the isometric view.) Numerical application of the Biot-Savart law is most practical for calculating gradient fields, leakage flux, and total inductance (from the total magnetic energy).

Detailed Description Text (30):
There are two general methods of orthogonally powering the diagonal crescents. In the first method, the center crescents each have one winding and the diagonal crescents each contain two sets of parallel windings, one set for each transverse axis. Each center crescent would typically have current density 40% greater than that of a single one of the windings on a diagonal crescent. This method has the advantage that each axis requires only one power amplifier. The x-amplifier drives the two crescents on the x-axis and one of the winding sets on each of the four diagonal crescents. The y-amplifier drives the two crescents on the y-axis and the other winding set on each of the diagonal crescents. One possible schematic representation of this approach is shown in FIG. 7. Here, each winding set consists of a single, full-length winding; the +z ends of the crescents are shown with dots, and all of the windings are counterclockwise when viewed from the +z end. In this case, the center crescents L.sub.c are in series with paralleled diagonal crescents L.sub.D, but many other series-parallel arrangements can be devised that produce the desired current densities and maintain orthogonality--that is, result in zero mutual inductance between the axes. The Golay coils are most conveniently wired in series with the crescents on each axis, as it is difficult to accurately calculate the separate inductances, but they can be paralleled with the crescents if the individual and mutual inductances can be accurately determined and matched along with proper resistance match. Of course, the fourfold symmetry allows simple parallel arrangements of the four quadrants with all coils per quadrant in series.

Detailed Description Text (31):
In the second general method, each diagonal crescent has only one winding set that

is shared by both axes, but four power amplifiers are required to drive the transverse axes. For purposes of illustration, the four amplifiers are assumed to have equal transconductance and the crescents have equal turns densities. This approach has the advantages of simplified crescent windings and interconnections, easier impedance matching, reduced interwinding capacitance, and higher efficiency. One possible schematic representation to this approach is shown in FIG. 8 using the same conventions as used in FIG. 7. Again, many series-parallel variations are possible that achieve the desired surface current densities on the crescents. The X and Y signals are summed before being fed into the X+Y amplifier, and their difference is fed into the X-Y amplifier. While such a configuration requires a minimum of five amplifiers for an X-Y-Z gradient system compared to three for conventional designs, this approach would often be less expensive in large systems, where amplifier cost is primarily determined by total power. The amplifiers for the center crescents would require higher power rating and perhaps higher output impedance than the diagonal gradient amplifiers since the Golay coils would be connected in series with the center crescents. The voltages driving the diagonal crescents and the diagonal turns densities may, of course, be multiplied by any convenient factor to allow the use of amplifiers of more convenient impedances at the different power levels while achieving the desired relative current densities. In large systems, eight amplifiers would usually be used in a balanced configuration.

Detailed Description Text (32):
The embodiment of FIGS. 4 through 8 uses eight crescents for an X-Y gradient system. Some additional improvement in both switching efficiency and linearity may be obtained in large systems through further azimuthal segmentation for further adjustment of the azimuthal current densities-but with increased complexity and higher cost.

Detailed Description Text (33):
FIG. 9 is a cross section through the z=0 plane of an X-Y gradient coil system using 12 crescents. In general, 4n crescents may be used, where n is an integer and the azimuthal current densities in the distributed crescents approximate that of a sine function. For 12 crescents centered at azimuthal positions .phi.=0.degree., 30.degree., 60.degree., 90.degree., 120.degree., 150.degree., . . . the y-current density at 60.degree. and 120.degree. is approximately 87% of that at 90.degree. and the y-current density at 30.degree. and 150.degree. is approximately half that at 90.degree.. For the case of twelve or more crescents azimuthally, it becomes impractical to achieve the desired current densities on both axes through multiple windings driven by one amplifier per axis in a similar manner to that shown in FIG. 7. However, the method of FIG. 8 using a single winding per crescent can easily be extended to any number of crescents.

Detailed Description Text (34):
FIG. 10 is a schematic representation of an arrangement using six amplifiers to drive twelve crescents for an X-Y system. The center crescents are wired in series with the Golay coils, and mixtures of the x and y signals are supplied to the off-axis crescents. Again, the relative voltages (or currents) and the turns densities may be scaled appropriately for more convenient amplifier impedances. The impedances of each crescent in the set at azimuthal positions .phi., .phi.+180.degree., -.phi., and 180.degree.-.phi. would be identical, but not necessarily related to the impedances of any other set of symmetrically related crescents by any relationship other than amplifier economics. Since the off-axis crescents would require lower power than the center crescents (especially when the Golays are in series with the center crescents), the off-axis crescents would normally be of higher impedance. That is, the off-axis crescents would normally have higher turns density, even though they would be operated at lower current density.

Detailed Description Text (35):

The crescent concept as a means of confining magnetic flux may be extended to more complex geometries with some additional improvement in both switching efficiency and shielding effectiveness but with increased complexity in the Biot-Savart numerical optimization, the manufacturing of the coilform, and in the coil winding or etching process. FIG. 11 shows one such extension of the crescent concept. The external concave cylindrical surface is symmetrically stepped to form a mid-external concave cylindrical surface 1120 with radius r.sub.g and two symmetrically located end-external concave cylindrical surfaces 1121, 1122 at radius r.sub.g +.epsilon., where .epsilon. is small compared to r.sub.g, so that the azimuthal windings on surfaces 1121, 1122, may overlap other coils on system coilform 401 at these axial locations. For example, it may be desirable to have a Z gradient winding 140 in this location to improve the linearity of the Z gradient. In such case of a Z gradient 1141 would desirably fit in stepped area 1126 and 1127. The external convex cylindrical surface may also be symmetrically stepped to form a mid-external convex cylindrical surface 1125 at radius r.sub.g +s and two symmetrically located end-external convex cylindrical surfaces 1126, 1134, at radius r.sub.g +s-.epsilon.. The crescent ends include annular sectors 1131, 1132, on which are mounted end-azimuthal conductors. Portions of hyperbolic surfaces of revolution 1133, 1134 join the end annular sectors to the end-concave cylindrical surfaces. Among the surfaces with azimuthal current conductors, the mean surface current density would be highest on the end-external concave cylindrical surfaces and lowest on the annular sectors. The windings of the crescent coil are desirably angled as shown in FIG. 11(b) so as to enhance flux confinement, thus, minimizing axial flux leakage and eddy currents in the magnet.

Other Reference Publication (1):
Y. Bangert and P. Mansfield, J. Physics E 15, "Magnetic Field Gradient Coils for NMR Imaging," 235 (1982).

Other Reference Publication (2):
P. Mansfield and B. Chapman, J. Magnetic Resonance 66, "Active Magnetic Screening of Gradient Coils in NMR Imaging," 573-576 (Feb. 1986).

Other Reference Publication (3):
P. Mansfield and B. Chapman, J. Magnetic Resonance 72, "Multishield Active Magnetic Screening of Coil Structures in NMR," 211 (1987).

Other Reference Publication (4):
M. K. Stehling, R. Turner, P. Mansfield, Science 254, "Echo-Planar Imaging: Magnetic Resonance Imaging in a Fraction of a Second," 43 (1991).

Other Reference Publication (5):
E. C. Wong et al., Magnetic Resonance in Medicine, vol. 21, 1 Sep. 1991, pp. 39-48.

Other Reference Publication (7):
J. P. Boehmer et al., Journal of Magnetic Resonance, vol. 83, 1 Jun. 1989, pp. 152-159.

CLAIMS:

1. An MRI transverse gradient coil system, referenced in a spherical coordinate system, substantially symmetric with respect to the equatorial plane .THETA.=90.degree. and substantially symmetric with respect to the longitudinal planes .phi.=0.degree. and .phi.=90.degree., said system comprising;

a nonmetallic, nonmagnetic cylindrical coilform of outer radius r.sub.g and inner radius r.sub.3 ;

a plurality of electrically conductive surface loops bonded to the outer surface of

said coilform, said loops centered at polar angle less than 60.degree.;

a plurality of axially aligned crescent coils bonded to the outer surface of said coilform at polar angle greater than 70.degree.;

each said crescent coil comprising:

a nonmetallic, nonmagnetic, crescent coilform having an external concave surface composed of a section of a cylinder of a radius approximately equaling r.sub.g and axial length h.sub.1 parallel to the crescent coilform axis, said crescent coilform defining an opposite external surface; said crescent coilform substantially symmetric with respect to a plane containing said coilform axis;

external conductive loops wound around said crescent coilform axis and bonded to said external surfaces to form azimuthally oriented parallel conductor elements on said concave surface and said opposite surface the conductor elements on each face defining a turns density, such that the mean turns density on said concave surface is higher than the mean turns density on said opposite surface;

further characterized by having a diagonal crescent coil with coilform axis positioned at 45.degree., an x-center crescent coil with coilform axis positioned at 0.degree., and a y-center crescent coil with coilform axis positioned at 90.degree..

2. The transverse gradient coil system of claim 1 further characterized in that h.sub.1 is is greater than r.sub.g /2 and less than 1.5 r.sub.g.

3. The transverse gradient coil system of claim 1 further characterized by having an x-center crescent coil with coilform axis positioned at 0.degree., a y-center crescent coil with coilform axis positioned at 90.degree., and 4n off-axis crescent coils, where n is a positive integer.

4. The transverse gradient coil system of claim 3 further characterized in that one of said center crescent coils has lower inductance than one of said off-axis crescent coils.

5. The transverse gradient coil system of claim 1 further characterized in that said diagonal crescent coils each have two parallel windings.

6. The coil system of claim 1 in which said coil support cylinder comprises a high-strength, high-modulus, high-thermal-conductivity, thin-walled cylinder and is water cooled on its inner surface.

7. The system of claim 1 wherein the cylindrical coilform comprises silicon nitride.

8. The system of claim 1 wherein the cylindrical coilform comprises alumina.

9. The system of claim 1 wherein the cylindrical coilform comprises an alumina-filled composite.

12. The system of claim 3 wherein n is 1, wherein there are two x-center crescent coils diametrically opposed, wherein there are two y-center crescent coils diametrically opposed, the x-center and y-center crescent coils defining on-axis crescent coils, and wherein the four off-axis crescent coils alternate with the four on-axis crescent coils thus defining diagonal crescent coils, further characterized in that said diagonal crescent coils each have first and second parallel windings.

13. The system of claim 12 wherein the x-center crescent coils are electrically

driven with the first windings of the diagonal crescent coils, and wherein the y-center crescent coils are electrically driven with the second windings of the diagonal crescent coils.

14. The system of claim 13 wherein the crescent coils are electrically driven by first and second amplifiers, the first amplifier receiving an x-signal and driving the x-center crescent coils and the first windings of the diagonal crescent coils, and the second amplifier receiving a y-signal and driving the y-center crescent coils and the second windings of the diagonal crescent coils.

15. The system of claim 3 wherein n is 1, wherein there are two x-center crescent coils diametrically opposed, wherein there are two y-center crescent coils diametrically opposed, the x-center and y-center crescent coils defining on-axis crescent coils, and wherein the four off-axis crescent coils alternate with the four on-axis crescent coils thus defining diagonal crescent coils.

16. The system of claim 15 wherein the crescent coils are electrically driven by first, second, third, and fourth amplifiers, the first amplifier receiving an x-signal and driving the x-center crescent coils, the second amplifier receiving a y-signal and driving the y-center crescent coils, the third amplifier receiving substantially a first linear function of the x-signal and y-signal and driving two diametrically opposed diagonal crescent coils, and the fourth amplifier receiving substantially a second linear function of the x-signal and y-signal and driving the other diagonal crescent coils.

18. The crescent coil of claim 1 wherein the loops are bonded to the coilform using a fiber-reinforced thermosetting material.

19. An MRI transverse gradient coil system, referenced in a spherical coordinate system, substantially symmetric with respect to the equatorial plane .THETA.=90.degree. and substantially symmetric with respect to the longitudinal planes .phi.=0.degree. and .phi.=90.degree., said system comprising:

a nonmetallic, nonmagnetic cylindrical coilform of outer radius r.sub.g and inner radius r.sub.3 ;

a plurality of electrically conductive surface loops bonded to the outer surface of said coilform, said loops having a mean polar angle less than 60.degree.;

a plurality of axially aligned crescent coils bonded to the outer surface of said coilform at polar angle greater than 70.degree.;

each said crescent coil comprising:

a nonmetallic, nonmagnetic crescent coilform having an external concave surface composed of a section of a cylinder of a radius approximately equaling r.sub.g and axial length h.sub.1 parallel to the crescent coilform axis, said crescent coilform defining an opposite external surface;

said crescent coilform substantially symmetric with respect to a plane containing said coilform axis;

external conductive loops wound around said crescent coilform axis and bonded to said external surfaces to form azimuthally oriented parallel conductor elements on said concave surface and said opposite surface the conductor elements on each face defining a turns density, such that the mean turns density on said concave surface is higher than the mean turns density on said opposite surface;

further characterized by having an x-center crescent coil with coilform axis positioned at 0.degree., a y-center crescent coil with coilform axis positioned at

90.degree., and 4n off-axis crescent coils, where n is a positive integer.

20. The transverse gradient coil system of claim 19 further characterized in that h.sub.1 is greater than r.sub.g /2 and less than 1.5 r.sub.g.

21. The transverse gradient coil system of claim 19 further characterized in that one of said center crescent coils has lower inductance than one of said off-axis crescent coils.

22. The coil system of claim 19 in which said coil support cylinder comprises a high-strength, high-modulus, high-thermal-conductivity, thin-walled cylinder and is water cooled on its inner surface.

23. The system of claim 19 wherein the cylindrical coilform comprises silicon nitride.

24. The system of claim 19 wherein the cylindrical coilform comprises alumina.

25. The system of claim 19 wherein the cylindrical coilform comprises an alumina-filled composite.

28. The crescent coil of claim 19 wherein the loops are bonded to the coilform using a fiber-reinforced thermosetting material.

29. The system of claim 19 wherein n is 1, wherein there are two x-center crescent coils diametrically opposed, wherein there are two y-center crescent coils diametrically opposed, the x-center and y-center crescent coils defining on-axis crescent coils, and wherein the four off-axis crescent coils alternate with the four on-axis crescent coils thus defining diagonal crescent coils, further characterized in that said diagonal crescent coils each have first and second parallel windings.

30. The system of claim 29 wherein the x-center crescent coils are electrically driven with the first windings of the diagonal crescent coils, and wherein the y-center crescent coils are electrically driven with the second windings of the diagonal crescent coils.

31. The system of claim 30 wherein the crescent coils are electrically driven by first and second amplifiers, the first amplifier receiving an x-signal and driving the x-center crescent coils and the first windings of the diagonal crescent coils, and the second amplifier receiving a y-signal and driving the y-center crescent coils and the second windings of the diagonal crescent coils.

32. The system of claim 19 wherein n is 1, wherein there are two x-center crescent coils diametrically opposed, wherein there are two y-center crescent coils diametrically opposed, the x-center and y-center crescent coils defining on-axis crescent coils, and wherein the four off-axis crescent coils alternate with the four on-axis crescent coils thus defining diagonal crescent coils.

33. The system of claim 32 wherein the crescent coils are electrically driven by first, second, third, and fourth amplifiers, the first amplifier receiving an x-signal and driving the x-center crescent coils, the second amplifier receiving a y-signal and driving the y-center crescent coils, the third amplifier receiving substantially a first linear function of the x-signal and y-signal and driving two diametrically opposed diagonal crescent coils, and the fourth amplifier receiving substantially a second linear function of the x-signal and y-signal and driving the other diagonal crescent coils.

35. The system of claim 19 wherein n is 2, wherein there are two x-center crescent coils diametrically opposed, wherein there are two y-center crescent coils

diametrically opposed, the x-center and y-center crescent coils defining on-axis crescent coils, and wherein the eight off-axis crescent coils are disposed pairwise between pairs of x-center and y-center crescent coils, the eight off-axis crescent coils defining four diametrically opposed pairs.

36. The system of claim 35 wherein the crescent coils are electrically driven by first, second, third, fourth, fifth and sixth amplifiers, the first amplifier receiving an x-signal and driving the x-center crescent coils, the second amplifier receiving a y-signal and driving the y-center crescent coils, the third amplifier receiving substantially a first linear function of the x-signal and y-signal and driving a first pair of diametrically opposed off-axis crescent coils, the fourth amplifier receiving substantially a second linear function of the x-signal and y-signal and driving a second pair of diametrically opposed off-axis crescent coils, the fifth amplifier receiving substantially a third linear function of the x-signal and y-signal and driving a third pair of diametrically opposed off-axis crescent coils, and the sixth amplifier receiving substantially a fourth linear function of the x-signal and y-signal and driving a fourth pair of diametrically opposed off-axis crescent coils.

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Search Results - Record(s) 1 through 4 of 4 returned.

☐ 1. Document ID: US 6812705 B1

Using default format because multiple data bases are involved.

L37: Entry 1 of 4 File: USPT Nov 2, 2004

US-PAT-NO: 6812705
DOCUMENT-IDENTIFIER: US 6812705 B1

TITLE: Coolant cooled RF body coil

DATE-ISSUED: November 2, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sellers; Michael Ben	Florence	SC		

US-CL-CURRENT: 324/318; 324/315

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

☐ 2. Document ID: US 6111412 A

L37: Entry 2 of 4 File: USPT Aug 29, 2000

US-PAT-NO: 6111412
DOCUMENT-IDENTIFIER: US 6111412 A

TITLE: Gradient coil assembly and method of production of same

DATE-ISSUED: August 29, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Schuster; Johann	Oberasbach			DE
Kaindl; Arthur	Erlangen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

☐ 3. Document ID: US 5886548 A

L37: Entry 3 of 4 File: USPT Mar 23, 1999

US-PAT-NO: 5886548
DOCUMENT-IDENTIFIER: US 5886548 A

TITLE: Crescent gradient coils

DATE-ISSUED: March 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

☐ 4. Document ID: US 5554929 A

L37: Entry 4 of 4 File: USPT Sep 10, 1996

US-PAT-NO: 5554929
DOCUMENT-IDENTIFIER: US 5554929 A

TITLE: Crescent gradient coils

DATE-ISSUED: September 10, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doty; F. David	Columbia	SC		
Wilcher; James K.	Columbia	SC		

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

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Term	Documents
PIPE	1452331
PIPES	507693
PLUMBING	29610
PLUMBINGS	13

PIPING	178111
PIPINGS	11967
PIPED	14224
PIPEDS	33
(36 AND (PIPED OR PLUMBING OR PIPING OR PIPE)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	4
(L36 AND (PIPE OR PLUMBING OR PIPING OR PIPED)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	4

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Search Results - Record(s) 1 through 10 of 10 returned.

1. Document ID: US 20030218460 A1

Using default format because multiple data bases are involved.

L40: Entry 1 of 10 File: PGPB Nov 27, 2003

PGPUB-DOCUMENT-NUMBER: 20030218460
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030218460 A1

TITLE: Mr gradient coil system with a shim tray receptacle at a position unaltered by temperature changes

PUBLICATION-DATE: November 27, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Heid, Oliver	Gunzenhausen		DE	

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. De

2. Document ID: US 20010043070 A1

L40: Entry 2 of 10 File: PGPB Nov 22, 2001

PGPUB-DOCUMENT-NUMBER: 20010043070
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010043070 A1

TITLE: "Magnetic resonance apparatus having a gradient coil system with magnetostrictive material"

PUBLICATION-DATE: November 22, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Heid, Oliver	Gunzenhausen		DE	

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. De

3. Document ID: US 20010033168 A1

L40: Entry 3 of 10 File: PGPB Oct 25, 2001

PGPUB-DOCUMENT-NUMBER: 20010033168
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010033168 A1

TITLE: Electrical coil

PUBLICATION-DATE: October 25, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Heid, Oliver	Gunzenhausen		DE	

US-CL-CURRENT: 324/322; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

4. Document ID: US 6819107 B2

L40: Entry 4 of 10 File: USPT Nov 16, 2004

US-PAT-NO: 6819107
DOCUMENT-IDENTIFIER: US 6819107 B2

TITLE: MR gradient coil system with a shim tray receptacle at a position unaltered by temperature changes

DATE-ISSUED: November 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

5. Document ID: US 6774631 B2

L40: Entry 5 of 10 File: USPT Aug 10, 2004

US-PAT-NO: 6774631
DOCUMENT-IDENTIFIER: US 6774631 B2

TITLE: Magnetic resonance gradient coil with a heat insulator disposed between the electrical conductor and the carrier structure

DATE-ISSUED: August 10, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

---

6. Document ID: US 6384604 B2

L40: Entry 6 of 10 File: USPT May 7, 2002

US-PAT-NO: 6384604
DOCUMENT-IDENTIFIER: US 6384604 B2

TITLE: "Magnetic resonance apparatus having a gradient coil system with magnetostrictive material"

DATE-ISSUED: May 7, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

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7. Document ID: US 6342785 B1

L40: Entry 7 of 10 File: USPT Jan 29, 2002

US-PAT-NO: 6342785
DOCUMENT-IDENTIFIER: US 6342785 B1

TITLE: Method for quantification and representation of in vivo fluid flow using magnetic resonance

DATE-ISSUED: January 29, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

8. Document ID: US 5668474 A

L40: Entry 8 of 10 File: USPT Sep 16, 1997

US-PAT-NO: 5668474
DOCUMENT-IDENTIFIER: US 5668474 A

TITLE: Method in the form of a pulse sequence for fast nuclear magnetic resonance imaging

DATE-ISSUED: September 16, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Bern			CH

US-CL-CURRENT: 324/309; 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

9. Document ID: JP 2001353136 A

L40: Entry 9 of 10 File: JPAB Dec 25, 2001

PUB-NO: JP02001353136A
DOCUMENT-IDENTIFIER: JP 2001353136 A
TITLE: ELECTRIC COIL

PUBN-DATE: December 25, 2001

INVENTOR-INFORMATION:

NAME	COUNTRY
HEID, OLIVER DR	

INT-CL (IPC): A61 B 5/055; G01 R 33/385; G01 R 33/3873

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

10. Document ID: US 6774631 B2, DE 10020264 C1, US 20010033168 A1, JP 2001353136 A, GB 2364784 A

L40: Entry 10 of 10 File: DWPI Aug 10, 2004

DERWENT-ACC-NO: 2001-550758
DERWENT-WEEK: 200453

TITLE: Electric coil, especially gradient coil for medical magnetic resonance device - has one section of coil conductor of hollow cylindrical shape for through-

flow of cooling medium

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw D

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Term	Documents
PLANAR	505025
PLANARS	157
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OPEN	3183480
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TEMPERATURE	3297263
TEMP	844430
TEMPS	79663
TEMPERATURES	1073568
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Search Results - Record(s) 1 through 2 of 2 returned.

1. Document ID: DE 19839987 A1

Using default format because multiple data bases are involved.

L41: Entry 1 of 2 File: EPAB Mar 9, 2000

PUB-NO: DE019839987A1
DOCUMENT-IDENTIFIER: DE 19839987 A1
TITLE: Directly cooled magnetic coil especially gradient coil for magnetic resonance equipment

PUBN-DATE: March 9, 2000

INVENTOR-INFORMATION:

NAME	COUNTRY
ARZ, WINFRIED	DE
STOCKER, STEFAN	DE

INT-CL (IPC): G01 R 33/385; H01 F 7/20
EUR-CL (EPC): G01R033/385; H01F007/20, H01F027/28

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

2. Document ID: US 6741152 B1, DE 19839987 A1, GB 2342986 A, DE 19839987 C2, GB 2342986 B

L41: Entry 2 of 2 File: DWPI May 25, 2004

DERWENT-ACC-NO: 2000-207130
DERWENT-WEEK: 200435
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TITLE: Directly cooled magnetic coil especially gradient coil for magnetic resonance equipment - as moulded segments of inter-twisted individual flexible leads of stranded conductor placed around cooling tube

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw. De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents

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19839987S	0
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(19839987).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	2

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Search Results - Record(s) 1 through 2 of 2 returned.

1. Document ID: US 6741152 B1

Using default format because multiple data bases are involved.

L42: Entry 1 of 2 File: USPT May 25, 2004

US-PAT-NO: 6741152
DOCUMENT-IDENTIFIER: US 6741152 B1

TITLE: Directly cooled magnetic coil, particularly a gradient coil, and method for manufacturing conductors therefor

DATE-ISSUED: May 25, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Arz; Winfried	Erlangen			DE
Stocker; Stefan	Erlangen			DE

US-CL-CURRENT: 335/300; 174/15.1, 174/15.6, 174/47, 336/62

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

2. Document ID: US 6741152 B1, DE 19839987 A1, GB 2342986 A, DE 19839987 C2, GB 2342986 B

L42: Entry 2 of 2 File: DWPI May 25, 2004

DERWENT-ACC-NO: 2000-207130
DERWENT-WEEK: 200435

TITLE: Directly cooled magnetic coil especially gradient coil for magnetic resonance equipment - as moulded segments of inter-twisted individual flexible leads of stranded conductor placed around cooling tube

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents

"6741152"	2
6741152S	0
"6741152".PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	2
(6741152).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	2

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Hit List

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Search Results - Record(s) 1 through 3 of 3 returned.

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1. Document ID: US 6819107 B2

Using default format because multiple data bases are involved.

L43: Entry 1 of 3 File: USPT Nov 16, 2004

US-PAT-NO: 6819107
DOCUMENT-IDENTIFIER: US 6819107 B2

TITLE: MR gradient coil system with a shim tray receptacle at a position unaltered by temperature changes

DATE-ISSUED: November 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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2. Document ID: DE 19721985 A1

L43: Entry 2 of 3 File: EPAB Dec 3, 1998

PUB-NO: DE019721985A1
DOCUMENT-IDENTIFIER: DE 19721985 A1
TITLE: NMR gradient coil assembly group with cooling system

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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3. Document ID: DE 19721985 A1, US 6111412 A, DE 19721985 C2

L43: Entry 3 of 3 File: DWPI Dec 3, 1998

DERWENT-ACC-NO: 1999-025387
DERWENT-WEEK: 200043

TITLE: NMR gradient coil assembly group with cooling system - includes gradient coil and cooling arrangement which comprises flexible cooling medium conductor arranged on flexible carrier

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
"19721985"	3
19721985S	0
"19721985".PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	3
(19721985).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	3

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Search Results - Record(s) 1 through 2 of 2 returned.

1. Document ID: DE 19722211 A1

Using default format because multiple data bases are involved.

L44: Entry 1 of 2 File: EPAB Aug 27, 1998

PUB-NO: DE019722211A1
DOCUMENT-IDENTIFIER: DE 19722211 A1
TITLE: Manufacturing procedure for forming an active screened gradient coil arrangement for magnetic resonance apparatus

PUBN-DATE: August 27, 1998

INVENTOR-INFORMATION:

NAME	COUNTRY
SCHUSTER, JOHANN	DE
BOEMMEL, FRANZ DR RER NAT	DE
HENTZELT, HEINZ	DE
ARZ, WINFRIED DIPL ING	DE

INT-CL (IPC): G01 R 33/385; H01 F 27/36
EUR-CL (EPC): G01R033/421

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Drawn De

2. Document ID: DE 19722211 A1

L44: Entry 2 of 2 File: DWPI Aug 27, 1998

DERWENT-ACC-NO: 1998-458057
DERWENT-WEEK: 199840

TITLE: Manufacturing procedure for forming an active screened gradient coil arrangement for magnetic resonance apparatus - involves initially assembling all gradient coil sets separately or modularly on first part of potting mould

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Drawn De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents

"19722211"	2
19722211S	0
"19722211".PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	2
(19722211).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	2

Display Format: - Change Format

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Hit List

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs
Generate OACS

Search Results - Record(s) 1 through 12 of 12 returned.

☐ 1. Document ID: US 20020008516 A1

Using default format because multiple data bases are involved.

L45: Entry 1 of 12 File: PGPB Jan 24, 2002

PGPUB-DOCUMENT-NUMBER: 20020008516
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020008516 A1

TITLE: Magnetic resonance apparatus having a mechanically damped gradient coil system

PUBLICATION-DATE: January 24, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Dietz, Peter	Nuernberg		DE	
Kaindl, Arthur	Erlangen		DE	
Schoen, Lothar	Neunkirchen		DE	

US-CL-CURRENT: 324/318; 324/307, 324/309, 324/315

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

☐ 2. Document ID: US 6844731 B2

L45: Entry 2 of 12 File: USPT Jan 18, 2005

US-PAT-NO: 6844731
DOCUMENT-IDENTIFIER: US 6844731 B2

TITLE: Magnetic resonance gradient coil system containing latent heat storage material which undergoes a phase transition during operation

DATE-ISSUED: January 18, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Endt; Axel Vom	Erlangen			DE

US-CL-CURRENT: 324/318; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw De

3. Document ID: US 6819107 B2

L45: Entry 3 of 12 File: USPT Nov 16, 2004

US-PAT-NO: 6819107
DOCUMENT-IDENTIFIER: US 6819107 B2

TITLE: MR gradient coil system with a shim tray receptacle at a position unaltered by temperature changes

DATE-ISSUED: November 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw De

4. Document ID: US 6781376 B2

L45: Entry 4 of 12 File: USPT Aug 24, 2004

US-PAT-NO: 6781376
DOCUMENT-IDENTIFIER: US 6781376 B2

TITLE: Gradient coil system with first and second transverse gradient coil axially offset on a common cylinder envelope and magnetic resonance apparatus having the gradient coil system

DATE-ISSUED: August 24, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schaaf; Michael	Oberreichenbach			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw De

5. Document ID: US 6774631 B2

L45: Entry 5 of 12 File: USPT Aug 10, 2004

US-PAT-NO: 6774631
DOCUMENT-IDENTIFIER: US 6774631 B2

TITLE: Magnetic resonance gradient coil with a heat insulator disposed between the electrical conductor and the carrier structure

DATE-ISSUED: August 10, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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6. Document ID: US 6771072 B2

L45: Entry 6 of 12 File: USPT Aug 3, 2004

US-PAT-NO: 6771072
DOCUMENT-IDENTIFIER: US 6771072 B2

TITLE: Magnetic resonance apparatus with an electrical conductor arrangement for electrical supply to a conduit

DATE-ISSUED: August 3, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schuster; Johann	Oberasbach			DE
Stocker; Stefan	Erlangen			DE

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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7. Document ID: US 6642717 B2

L45: Entry 7 of 12 File: USPT Nov 4, 2003

US-PAT-NO: 6642717
DOCUMENT-IDENTIFIER: US 6642717 B2

TITLE: Magnetic resonance apparatus having a mechanically damped gradient coil system

DATE-ISSUED: November 4, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Dietz; Peter	Nuremberg			DE
Kaindl; Arthur	Erlangen			DE

Schoen; Lothar	Neukirchen			DE

US-CL-CURRENT: 324/318; 324/309, 324/320

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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8. Document ID: US 6552545 B2

L45: Entry 8 of 12 File: USPT Apr 22, 2003

US-PAT-NO: 6552545
DOCUMENT-IDENTIFIER: US 6552545 B2

TITLE: Gradient coil with direct cooling

DATE-ISSUED: April 22, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaindl; Arthur	Erlangen			DE
Schoen; Lothar	Neunkirchen			DE
Schuster; Johann	Oberasbach			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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9. Document ID: US 6525537 B2

L45: Entry 9 of 12 File: USPT Feb 25, 2003

US-PAT-NO: 6525537
DOCUMENT-IDENTIFIER: US 6525537 B2

TITLE: Magnetic resonance apparatus having a single-circuit cooling circulation system

DATE-ISSUED: February 25, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nerreter; Ulrich	Nuremberg			DE

US-CL-CURRENT: 324/322; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw De

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10. Document ID: US 6236207 B1

L45: Entry 10 of 12 File: USPT May 22, 2001

US-PAT-NO: 6236207
DOCUMENT-IDENTIFIER: US 6236207 B1

TITLE: Coil system for magnetic resonance systems with integrated cooling unit

DATE-ISSUED: May 22, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Arz; Winfried	Erlangen			DE
Schuster; Johann	Oberasbach			DE

US-CL-CURRENT: 324/318; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. D

11. Document ID: US 6111412 A

L45: Entry 11 of 12 File: USPT Aug 29, 2000

US-PAT-NO: 6111412
DOCUMENT-IDENTIFIER: US 6111412 A

TITLE: Gradient coil assembly and method of production of same

DATE-ISSUED: August 29, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Schuster; Johann	Oberasbach			DE
Kaindl; Arthur	Erlangen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw. D

12. Document ID: DE 19721985 A1, US 6111412 A, DE 19721985 C2

L45: Entry 12 of 12 File: DWPI Dec 3, 1998

DERWENT-ACC-NO: 1999-025387
DERWENT-WEEK: 200043

TITLE: NMR gradient coil assembly group with cooling system - includes gradient coil and cooling arrangement which comprises flexible cooling medium conductor arranged on flexible carrier

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
"6111412"	12
6111412S	0
"6111412".PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	12
(6111412).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	12

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Search Results - Record(s) 1 through 13 of 13 returned.

☐ 1. Document ID: US 20030222650 A1

Using default format because multiple data bases are involved.

L46: Entry 1 of 13 File: PGPB Dec 4, 2003

PGPUB-DOCUMENT-NUMBER: 20030222650
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030222650 A1

TITLE: Shim tray, and gradient coils system and magnetic resonance apparatus for the acceptable of the shim tray

PUBLICATION-DATE: December 4, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Boemmel, Franz	Erlangen		DE	
Franzke, Udo	Uttenreuth-Weiher		DE	

US-CL-CURRENT: 324/322; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw De

☐ 2. Document ID: US 20030214300 A1

L46: Entry 2 of 13 File: PGPB Nov 20, 2003

PGPUB-DOCUMENT-NUMBER: 20030214300
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030214300 A1

TITLE: Shim tray, and gradient coils system and magnetic resonance apparatus for the acceptable of the shim tray

PUBLICATION-DATE: November 20, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Bommel, Franz	Erlangen		DE	
Franzke, Udo	Uttenreuth-Weiher		DE	

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw De

3. Document ID: US 20030206018 A1

L46: Entry 3 of 13 File: PGPB Nov 6, 2003

PGPUB-DOCUMENT-NUMBER: 20030206018
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030206018 A1

TITLE: Magnetic resonance apparatus and carrier device equipable with shim elements

PUBLICATION-DATE: November 6, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Gebhardt, Matthias	Erlangen		DE	
Gebhardt, Norbert	Kirchehrenbach		DE	
Schuster, Johann	Oberasbach		DE	

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw De

4. Document ID: US 20010033168 A1

L46: Entry 4 of 13 File: PGPB Oct 25, 2001

PGPUB-DOCUMENT-NUMBER: 20010033168
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010033168 A1

TITLE: Electrical coil

PUBLICATION-DATE: October 25, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Heid, Oliver	Gunzenhausen		DE	

US-CL-CURRENT: 324/322; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw De

5. Document ID: US 6822453 B2

L46: Entry 5 of 13 File: USPT Nov 23, 2004

US-PAT-NO: 6822453

DOCUMENT-IDENTIFIER: US 6822453 B2

TITLE: Shim tray, and gradient coils system and magnetic resonance apparatus for the acceptable of the shim tray

DATE-ISSUED: November 23, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boemmel; Franz	Erlangen			DE
Franzke; Udo	Uttenreuth-Weiher			DE

US-CL-CURRENT: 324/320; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

6. Document ID: US 6819107 B2

L46: Entry 6 of 13 File: USPT Nov 16, 2004

US-PAT-NO: 6819107
DOCUMENT-IDENTIFIER: US 6819107 B2

TITLE: MR gradient coil system with a shim tray receptacle at a position unaltered by temperature changes

DATE-ISSUED: November 16, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D

7. Document ID: US 6798205 B2

L46: Entry 7 of 13 File: USPT Sep 28, 2004

US-PAT-NO: 6798205
DOCUMENT-IDENTIFIER: US 6798205 B2

TITLE: Shim tray, and gradient coils system and magnetic resonance apparatus for the acceptable of the shim tray

DATE-ISSUED: September 28, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY

Bommel; Franz	Erlangen			DE
Franzke; Udo	Uttenreuth-Weiher			DE

US-CL-CURRENT: 324/319; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw D

☐ 8. Document ID: US 6774631 B2

L46: Entry 8 of 13 File: USPT Aug 10, 2004

US-PAT-NO: 6774631
DOCUMENT-IDENTIFIER: US 6774631 B2

TITLE: Magnetic resonance gradient coil with a heat insulator disposed between the electrical conductor and the carrier structure

DATE-ISSUED: August 10, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heid; Oliver	Gunzenhausen			DE

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw D

☐ 9. Document ID: US 6342787 B1

L46: Entry 9 of 13 File: USPT Jan 29, 2002

US-PAT-NO: 6342787
DOCUMENT-IDENTIFIER: US 6342787 B1

TITLE: Real-time multi-axis gradient distortion correction using an interactive shim set

DATE-ISSUED: January 29, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Petropoulos; Labros S.	Solon	OH		
Schlitt; Heidi A.	Chesterland	OH		
Thompson; Michael R.	Cleveland Heights	OH		

US-CL-CURRENT: 324/320; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw D

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10. Document ID: US 6208141 B1

L46: Entry 10 of 13 File: USPT Mar 27, 2001

US-PAT-NO: 6208141
DOCUMENT-IDENTIFIER: US 6208141 B1

TITLE: Method and apparatus for mounting gradient tube to diagnostic imaging device

DATE-ISSUED: March 27, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Amor, Sr.; William H.	Chagrin Falls	OH		
Alden, Sr.; Jerome S.	Aurora	OH		
Morich; Michael A.	Mentor	OH		
Gruden; James L.	Kirtland Hills	OH		

US-CL-CURRENT: 324/318; 324/307, 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. De

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11. Document ID: US 5999076 A

L46: Entry 11 of 13 File: USPT Dec 7, 1999

US-PAT-NO: 5999076
DOCUMENT-IDENTIFIER: US 5999076 A

TITLE: Magnetic resonance imaging passively shimmed superconducting magnet assembly

DATE-ISSUED: December 7, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Becker, Jr.; Robert Henry	Burlingame	CA		
Hayworth; Gregory F.	Florence	SC		
Herd; Kenneth Gordon	Niskayuna	NY		
Huang; Xianrui	Florence	SC		
Morgan; Peter Angus	Scotia	NY		
Ranze; Richard Andrew	Scotia	NY		
Xu; Minfeng	Florence	SC		

US-CL-CURRENT: 335/301; 324/320

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw. De

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12. Document ID: US 5786695 A

L46: Entry 12 of 13 File: USPT Jul 28, 1998

US-PAT-NO: 5786695
DOCUMENT-IDENTIFIER: US 5786695 A

TITLE: Shim tray with reduced heat conduction and forced cooling

DATE-ISSUED: July 28, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Amor; William H.	Chagrin Falls	OH		
Alden; Jerome S.	Reminderville	OH		
DeMeester; Gordon D.	Wickliffe	OH		
Gruden; James L.	Kirtland Hills	OH		
Ling; Junxiao	University Heights	OH		

US-CL-CURRENT: 324/320; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Drawu De

13. Document ID: US 5786695 A
L46: Entry 13 of 13 File: DWPI Jul 28, 1998

DERWENT-ACC-NO: 1998-436672
DERWENT-WEEK: 199837

TITLE: Shim set for MRI apparatus - has shim trays with pockets retaining shims spaced from inner edge of secondary gradient coil to define cooling passage

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Drawu De

Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
"5786695"	13
5786695S	0
"5786695".PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	13
(5786695).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	13

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